The city's offer was $476,000. This was based on a payment of $447,578 for the pipe lines; office records, operating equipment and supplies made up the remaining $28,422. The owners of the property, while frankly accepting the city's appraisal of their property as fair, refused the offer on the ground that the Public Service Board was proposing to buy only a part of the property and was confiscating the remainder that it proposed to include with the pipe lines.

The Public Service Commission defended its position on the following basis: The company had successfully demonstrated to the court that, because of pumpage, its water tax was an equitable one. The city was prepared to sell water at nearly half the company rate and still make a profit. Los Angeles now had an abundance of water from the aqueduct, and the citizens of the Hollywood district were entitled to the enjoyment of municipal service. The only question, then, was whether an entirely new system should be built or the company's pipe lines purchased, improved and extended. Adoption of the first plan, from estimates already prepared, would cost $1,500,000; but a rate war would follow, many miles of improved streets would be torn up, and there would result a large economic waste that the water consumer would in the end have to pay.

The board recognized that the company had been a pioneer and had helped to build up the district. On this account the board was willing to take over and pay for, in adequate amount, any works that would prove of use, despite the fact that purchase meant heavy expenditures and replacements, because poor service endured from the company would not be brooked from the city.

Board Puts Limit on What It Will Pay For

The board at this time (Aug. 14, 1914) refused the purchase of any lands, reservoirs, rights-of-way or pumping equipment as not needful for its purposes. The company had procured extensions almost exclusively by requiring tract owners into whose property mains were extended to pay the cost thereof and give a bill of sale. These extensions the company had successfully capitalized before the courts as a part of its investment. (A recent California law makes this no longer possible.) This judgment the Public Service Board did not attempt to go behind in its offer of $476,000. It did, however, decline to pay the amount of $103,983 for street paving, because it was found almost without exception that the company had laid its mains before any extensive paving was undertaken in the district. Whether it would cost the city $103,983 for paving if a new system were built, the board maintained, did not enter into the question before the company and the city.

The board also refused to pay for any services or any meters. This refusal was on the ground that every consumer had been required to pay outright for the service and for the meter. Whether or not he could show a receipt was immaterial. The charges of the company were of record for these items. The company showed where it was required to maintain services and meters in perpetuity. The board, however, from a record of its own costs on these items, showed that the high prices charged by the company for meter and service installation, if the company had so handled its funds, would pay the cost and leave a surplus, the interest on which would take care of all repairs and renewals in perpetuity. Under these circumstances the board, acting as the trustees of the water consumers of the district, refused to make them pay for things which they had already once purchased. Liability insurance was disallowed without discussion.

No Allowance for Going Value

The item of $60,000 for good will and going value also was disallowed. From the protests of consumers it was evident that good will was a negligible item of appraisal, as not being in existence. Going value was considered. It was felt that going value represented the desirability of the security in which the investment was made. The inclusion of this item in the appraisal was fair, provided the company enjoyed the assurance of continued operation under normal conditions. The board firmly intended, however, to build a new system if an agreement with the company could not be entered into. The company could not hope to compete for long with the city's gravity system; and the going value, if any existed under the conditions, was entirely dependent upon whether the city would agree to take over such parts of the system as it could find use for. To pay any part of the $60,000 was to pay for something which the city itself was absolutely creating, and the item was therefore cut out of the appraisal.

The company felt safe in declining the proposal, for the board had no money at its disposal to make the purchase and to commence the immediate building of a new system. The company, therefore, after refusing to negotiate further, began a broadside newspaper-advertising campaign to force the board to place the whole matter of settlement before the State Board of Railroad Commissioners on the basis of the board's own engineering valuation of the property, hoping thereby to secure payment at least for meters and services and probably, also, severance damage. Delegations of business men, acting in good faith, but anxious for a settlement, by representatives and petition urged the board to this end.

Not Moved by State Railroad Commission

No commission of the state bears a higher respect for its probity and efficiency than the Railroad Commission, but the Public Service Board refused to be moved by all the pressure that was imposed. The board members disclaimed any hostility whatsoever against the company or its officials. They maintained that they had been appointed to manage the water properties and service of the city; they proposed, so long as they were in office, to manage that business in the same manner that they would conduct it as a private corporation with themselves as stockholders and directors. They had offered for the property what they considered it actually worth to the city, and they declined to be moved by manufactured public opinion.

In January, 1915, at the session of the state legislature the city procured the passage of the so-called Benedict Act, a measure which provides for the formation of an improvement district within a municipality. The procedure and methods of forming the district are the same as for the formation of an irrigation district in unincorporated territory. The board refused to make any further water sales to the company, and on July 5, after several strenuous days, officials of the corporation capitulated. The pipe-line system, outside as well as inside the city,

a water-works yard, miscellaneous equipment, a year's improvements and a quantity of newly purchased cast-iron pipe brought the purchase price up to a grand total of $579,080.

With no money to pay for the works and pending the time at which a bond election could be held, the board at once took a lease and 18 months' option to purchase, paying $25,000 out of the water revenues as an initial payment and $20,000 per month to apply on the principal and deferred interest. The rates of the company were then continued in effect, and the investment about carries itself from sales of water.

In August, as soon as the Benedict Act became operative, the board, in coöperation with improvement associations of the locality, procured the formation of the district and carried to a successful issue the voting of a $1,020,000 bond issue by a vote of 4,299 to 408, or at the ratio of 10 to 1.

As soon as the bonds can be issued and sold, the rates will be reduced to those effective on the old city system. Of the amount voted, $510,000 will be applied to that part of the Union Hollywood system within the district, the remainder will be expended in enlarging and extending laterals and the construction of three large trunk lines, two of which will act as feeders to provide an adequate flow from the aqueduct system. On that part of the system not included within the district the old company rates will be maintained until the lines pay for themselves, requiring, it is estimated, about three years.

Engineering Co-operation

By C. E. Drayer*

One thing that stands out clearly in a study of the world's progress in recent years is the tendency to bring together scattered and highly specialized activities into organizations where effort is coördinated to the end that the product of the whole shall be of greater and improved quality with a benefit accruing to both producers and consumers. Whether the product is of the hand or of the brain, this statement holds true.

That engineers are somewhat behind other groups of men in the general movement toward coöperation is probably due to the youth of the profession. The period of selfish specialization, from which we are emerging, is one of normal development preceding the days of greater fruition when we begin to study the wider interests of ourselves and of mankind about us. At first the individual engineer worked in isolation, mentally if not physically. Then came the desire to mingle with his fellows, and the engineering society was born. Today there is a current, obvious to all, setting in the direction of an organization in which the collective efforts of engineers will be administered for the good of the profession and the public. Let us recite a few developments, some quite recent, illustrating this organized effort.

In the Northwest there is in process of formation the Minnesota Joint Engineering Board, whose avowed aim is to secure effective coöperation among engineers for the good of the profession, to correlate the work of engineering organizations for unity of action, to improve standards of practice and to bring about a clearer recognition of the engineer as a civic asset. The chairman of the organization (E. T. Street) is chairman of the Minnesota Branch of the American Institute of Electrical Engineers, and the secretary (Geo. W. Rathjens) is last past-president of the Civil Engineers Society of St. Paul. One of the present activities of the Minnesota engineers is an effort to have an engineer appointed to the Board of Regents of the State University.

While the writer is not informed as to the full scope of the Minnesota board, it appears to be an excellent arrangement for correlating the interests of the local, state and national engineering societies within the borders of the state. The logical correlation of the efforts of state organizations remains to be worked out, perhaps by the national societies, when the one with the spirit of progress undertakes the leadership.

Engineers in other states are making organized effort to secure the appointment of engineers on public-service commissions. Engineers of Spokane, Wash., wrote to the governor of Idaho, asking him to consider the selection of an Idaho engineer to fill a vacancy on the State Public Service Commission. Pennsylvania engineering societies requested the governor, on more than one occasion, to appoint an engineer on the Public Service Commission. If the first efforts of this sort are not successful, it remains for the engineer through long and hard work to teach the public by word and deed that the engineer is an honest and efficient public servant, capable of taking administrative control. The ear of the politician is ever turned to the voice of numbers.

Beginning in 1909, the Engineers Society of Pennsylvania has held at Harrisburg five state conferences and exhibits to promote engineering coöperation, industrial and public welfare, safety and industrial efficiency. These conferences have been excellent means of educating the public and have been so satisfactory to all concerned that state departments have sought to take them over, presumably because they were successful undertakings. This same society was instrumental in promoting the act authorizing the appointment of an engineering commission to take evidence and report with recommendations in reference to a licensing law. The report of the committee, made to the governor, has just been made public. (See *Engineering News*, Mar. 9, 1916, p. 484.)

Licensing by states, or other suitable regulation of engineering practice, is demanded in many quarters by engineers as well as by the public. This subject requires broad and unselfish consideration. It is well for us to take cognizance of what the doctors, lawyers and architects have done, and it is pertinent to say that each class must work out its own salvation according to the elements of the problem of which it alone is best able to judge. Two reasons come to mind why action should be prompt. On the one hand, due to the organized activities of architects, laws have been passed in some states which make the engineer an employee of the architect. Control is completely in the hands of architects, because the state board of examiners is composed of architects. Had the engineers of Illinois, for instance, been organized to combat this pernicious legislation before it became law, they would have spared themselves humiliation and labor. On the other hand, there is a movement among engineers in at least two places to standardize wages. These conditions were theories a few years ago; today they are facts. Perhaps a recommendation by the national societies for standard practice in licensing would find favor.

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Within comparatively recent years there have sprung up in our larger cities local engineering societies which have met a real demand, as is evidenced by their rapid growth and continued success. They furnish that companionship which must be found at home and which the national societies cannot give, even by the formation of local sections of their own members. In any community there should be a local society containing all the engineers residing there. The fancied opposition of interest of local and national societies is based on a lack of comprehensive understanding and is absurd. Local sections there should be, within the local society. Strong national and strong local societies should be mutually helpful.

We must not lose sight of the fact that individual progress and growth are promoted by close acquaintance and that it is broadening to a man to attend meetings, hear papers and take part in discussions outside of his restricted specialty. It is increasing the worth of the individual until he is capable of leadership that will put the engineering profession to the front.

Particularly in the smaller political divisions, like counties or cities, there is need of concerted action. The appearance before the local public of a united group of technical men capable of giving intelligent opinion on public questions would enable engineers to exert influence for good on local government. This work cannot be effectively done, if at all, from the headquarters of a national society; but there should be a national organization to promote efficient management of the local society and to furnish stimulation and continuity of action.

Definite progress in coöperation has been made between engineers themselves and between engineers and the public in Buffalo, St. Paul, Philadelphia, St. Louis, Cleveland, Detroit, Pittsburgh, Nashville, Chicago and other places. The Civil Engineers Society of St. Paul secured the appointment of an engineer on the St. Paul charter commission, to whom has been assigned the chairmanship of the committee to draft provisions in the charter covering engineering activities of the city. He is also a member of the committee on civil-service rules. A committee of the Buffalo Engineering Society advises with the newly elected city commissioners. In Philadelphia a Development Committe has been named to formulate and solve problems arising from the recent acquisition of a large number of members. The experiences of this and other societies should be made available in concise form for the guidance of sister organizations throughout the country. Local societies of Pittsburgh, Detroit, Buffalo and Cleveland have visited each other during the past three years, promoting an acquaintance which is of value to all. The Cleveland society plans to publish later in the year a booklet, not so much for the information of the engineer as to explain to the intelligent layman what the work of the engineer is. Other societies will be asked to coöperate in the publication and marketing of this experimental magazine.

Committee on Engineering Coöperation

About a year ago, almost simultaneously, two organizations were formed having a similar purpose, but differing in their methods of bringing it about. The American Association of Engineers was organized to raise the standard of ethics of the engineering profession and to promote the economic and social welfare of engineers. Emphasis is laid on the commercial phases of engineering. The Committee on Engineering Coöperation is composed of volunteer members who seek to bring about coöperation through existing organizations:[1] When a society is found capable and willing to carry on the work of this committee, its self-imposed duties will be lightly transferred and the existence of the committee will have been justified.

An invitation has been issued by this committee to all engineering organizations to send delegates to a conference on engineering coöperation, to be held Apr. 13 and 14 in the rooms of the Western Society of Engineers, Monadnock Block, Chicago. The following items among others may be considered:

1. Coöperation among engineering organizations. Is it desirable? In what way is it practicable?
2. Benefits of coöperation in securing greater efficiency in the larger matters of concern to the individual engineer, to the profession and to the public.
3. Methods of coöperation now in practice in various localities; results attained in Philadelphia, St. Louis, St. Paul and other places.
4. Various kinds of engineering societies and committees and the relative efficiency of their operations.
5. Relation of the specialized or exclusive national engineering societies to their local sections or branches and to the more inclusive local engineering society or club.
6. Result of coöperation in securing wider diffusion of knowledge on engineering subjects, as illustrated at Cleveland and elsewhere.
7. The engineering profession as a whole in its present condition as regards public esteem.
8. Reasons for decline in attendance at engineering colleges. Is it indicative of heathful conditions or of proper methods of education?
9. Employment; methods and results as practiced by various engineering societies; an exchange of ideas.
10. Legislative activity, proper limits to be set, dangers to be avoided and needs of more systematic and better-directed efforts.

It is desired that a representative body of engineers attend this meeting and be prepared to take part in the discussion. If it is impossible to send delegates, it is hoped that as many as possible will give the matter of procedure and organization careful thought and give the committee the benefit through written discussion.

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Leakage from Water-Works Pipe Joints is being investigated by a committee of the New England Water-Works Association, of which F. A. Barbour, Tremont Building, Boston, Mass., is chairman. In a circular letter addressed by the committee to possible suppliers of information it is stated that much water and consequently much money are wasted through leakage from street mains. The committee then proceeds to ask these questions: "What is the best shape of joint? The best material? Are we using sufficient care and the best methods in making joints? What should be the specified or attempted tightness in new work? Does leakage through the joints now generally employed—even if originally small—increase after the pipe has been laid some time, and if so, can a joint to prevent this be developed?" To answer these very pertinent questions the committee has prepared an inquiry blank that it has sent to the members of the association. Information will also gladly be received from any water-works man, whether a member of the association named or not. To that end, blanks will be supplied on receipt of requests addressed simply to Secretary, New England Water-Works Association, Tremont Temple, Boston, Mass.

[1]The membership of the committee is: F. H. Newell, chairman, University of Illinois, Urbana, Ill.; C. E. Drayer, secretary, Cleveland, Ohio (secretary, Cleveland Engineering Society); Willard Beahan, Cleveland, Ohio (past-president, Cleveland Engineering Society); H. H. Esselstyn, Detroit, Mich. (past-president, Detroit Engineering Society); Farley Gannett, Harrisburg, Penn. (past-president, Engineers Society of Pennsylvania); Charles R. Gow, West Roxbury, Mass. (civil engineer and contractor); George H. Herrold, St. Paul, Minn. (president, Civil Engineers Society of St. Paul); A. J. Himes, Cleveland, Ohio (past-president, Cleveland Engineering Society); John C. Hoyt, Washington, D. C. (president, Washington Engineering Society); A. Stucki, Pittsburgh, Penn. (past-president, Engineers Society of Western Pennsylvania); D. Robert Yarnall, Philadelphia, Penn. (vice-president, Engineers Club of Philadelphia); John Younger, Buffalo, N. Y. (president, Engineers Society of Buffalo).

Cylinder-Pier Foundations of the Lincoln Memorial*

By James A. O'Connor†

SYNOPSIS—Details of layout and construction of deep pier footings under Lincoln Memorial on what was the old Potomac flats at Washington, D. C. Unique and difficult cylinder-pier work. Operations are under direction of Office of Public Buildings and Grounds, with Col. W. W. Harts, Corps of Engineers, U. S. A., in charge.

The Lincoln Memorial at Washington is situated at one end of what might be called the main axis, or base line, of the grand development running west from the Capitol and which is fixed by the Capitol building, the Washington Monument and the Lincoln Memorial. Their centers are on a straight line running practically through the center of the present West Potomac Park. When L'Enfant's plan was developed, the section of the present park west of the Washington Monument was an expanse of tidal mud flats. Within the past 30 years this marshy area has been filled in by material dredged from the Potomac River. During the discussions preceding the appropriation of the necessary funds for the memorial and the approval of the design, great stress was laid upon the lack of a practicable foundation, especially a foundation suitable for the massive monumental structure which was deemed necessary to fit in with the general proposed plan of the capital city and to represent by its dignity, grandeur and loftiness of purpose the character of Lincoln.

The problem was to provide a stable foundation for a structure 204 ft. long by 134 ft. wide, with a total weight at the original grade level of approximately 50,000 tons distributed among 106 piers.

To understand more clearly the foundation problem, a brief description of the structure will be given. It consists of a memorial hall, 84 ft. wide and 156 ft. long, surrounded by a colonnade of 36 massive columns representing the 36 states at the time of Lincoln's death. The height of the building itself is about 83 ft., and the memorial hall is divided into three sections by two rows of interior columns 50 ft. in height. The central and main section is to contain the main feature, a statue of Lincoln of heroic size, and the side sections are to contain memorial tablets of his Gettysburg speech and of his second inaugural address. The base of the building is 45 ft. above the original grade level and will be reached by means of terraces. The building is of white marble, obtained from the Colorado-Yule quarries at Marble, Colo.

Details of Two Parts of Foundations

The foundations are, for convenience, divided into two parts—the upper foundations, including the part above the original grade level (El. 16); and the subfoundations, extending from the original grade level down to rock.

The upper foundations consist of 106 rectangular concrete piers, which vary in size from 3x6 ft. to 7 ft. 4 in. by 11 ft. and are 45 ft. high. The 3x6-ft. piers are reinforced, and the 46 piers supporting the superstructure columns are hollow, with walls 2 ft. thick. Connecting the exterior piers are reinforced-concrete walls 1 ft. thick. The piers support the beams, arches and the main floor. The concrete was a 1:2:4 gravel mixture, with the exception of the solid nonreinforced piers, which were of a 1:3:6 mixture.

The subfoundation, which is described in more detail later, consists of reinforced-concrete piers supporting the upper foundation piers and extending down to, and 2 ft. into, bedrock.

The ground is as shown in Fig. 1. The upper 16 ft. is a loamy sand, which showed no settlement under a test load of 4 tons per sq.ft. Below this layer, extending down to rock, is what was generally considered to be mud. Actually, except for the top 2 ft., which had been turned to mud by the ordinary vegetable growth in a tidal flat, the material is a kind of blue clay, which showed no settlement with a load of 1 ton per sq.ft. The bedrock, which is a gneiss, is, as shown, an average of 49 ft. below the original ground level. The bedrock is covered by a 2-ft. layer of disintegrated rock.

Twenty wet test borings were made; these showed the clay layer to be comparatively soft and of doubtful value

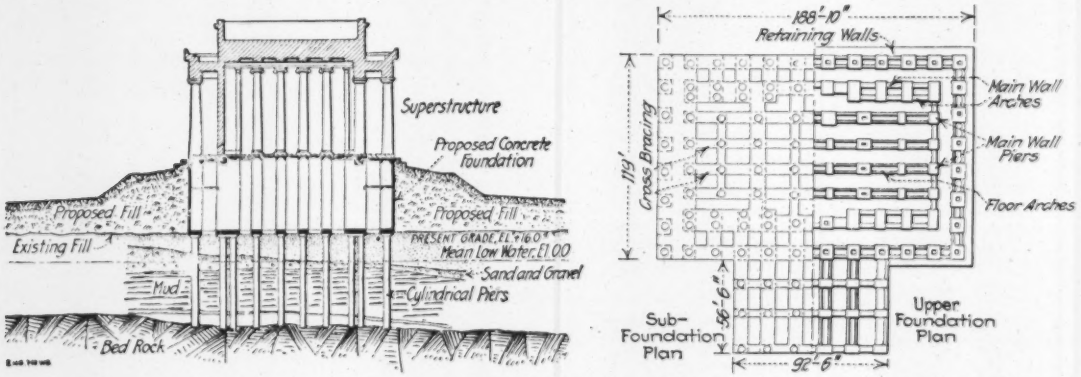


FIG. 1. VERTICAL AND HORIZONTAL SECTIONS THROUGH LINCOLN MEMORIAL, SHOWING DETAILS OF FOUNDATIONS

*From "Professional Memoirs, Corps of Engineers, United States Army and Engineer Department at Large," March-Apr. 1, 1916.

†Captain, Corps of Engineers, U. S. A., Washington, D. C.

as a suitable foundation. Moreover, foundations on a similar material in this locality had not proved altogether satisfactory. Rock of a more stable character was within reach, and there was but small disposition on the part of those responsible for the construction of the building, or on the part of Congress, to do any experimenting with a $2,000,000 monumental structure. Spread foundations might prove satisfactory, but rock foundations certainly would and were adopted.

FIG. 2. VIEW OF LINCOLN MEMORIAL FOUNDATIONS IN COURSE OF CONSTRUCTION

Cylinders forming the subfoundations are shown in the process of sinking, and piers forming the intermediate foundations between the subfoundations and the building proper are also illustrated. The connecting grillage is shown in the background of the view; the reinforcement of the cylinders is shown in the middle foreground; the method of sinking by placing weights on the cylinders, assisted by water jet on the outside, is shown at the right and left sides, and the concrete piers of the intermediate foundations are shown in the distance

As a result of the investigation the following conditions for a suitable foundation were decided upon:

1. That the foundation should consist of piers extending to and bearing on the underlying rock.

2. As the safe resisting pressure of the rotten rock was an unknown quantity and was undoubtedly less than that of good concrete and since the safe rock pressure should be at least equal to that of the concrete in the piers, the second requirement was that the foundation piers should extend through the rotten rock and bear on the firm rock.

3. Since, due to the uncertain nature of the wet-clay layer, it was expected that the fill of about 1,000,000 yd. around the building might result in horizontal pressures, as a provision for resistance against sliding, it was required that the foundation piers should extend into the firm rock at least 2 ft.

4. As the unsupported length of the foundation piers varies from 42 to 53 ft., provision against bending due to horizontal thrust was required; hence it was decided that the foundation piers should be considered as columns and should be of sufficient cross-section, or be properly reinforced, to resist horizontal pressure.

On the foregoing basis, piles could not be considered. The original plans showed large rectangular plain concrete piers extending into the rock. In the bids, however, alternate plans were proposed at a considerably reduced cost. In these plans steel cylinders were to be sunk to rock, the interiors excavated and filled with reinforced concrete. One plan provided for grouping 2-ft. cylindrical piers under the main piers and another for using large cylindrical piers, averaging 4 ft. in diameter, excepting for the largest main piers, where two for each pier were to be used.

The latter plan was submitted by M. F. Comer & Co., of Toledo, Ohio, with the lower bid of $215,000 and was accepted. The highest bid for the rectangular piers was $442,000 and the lowest $278,000. The accepted subfoundation plan in detail is as follows:

It consists of 122 reinforced-concrete circular piers, which extend 2 ft. into the solid rock at the bottom and which are tied together with a crossbracing at their tops at the original ground level. The diameter of these piers varies from 3 ft. 6 in. to 4 ft. 2 in., and they are reinforced with twelve 1¼-in. square twisted steel rods, with the exception of the piers 3 ft. 6 in. in diameter, which are reinforced with twelve 1-in. rods. The forms for

the subfoundation piers were steel cylinders, ½ in. thick for the lower 20 ft. and ⅜ in. thick for the remainder. The cylinders were sunk to rock, the earth and rock were excavated, the reinforcing steel was placed, and the cylinders were then filled with concrete. The crossbracing at the original ground level is concrete 1 ft. thick, reinforced with ¾-in. square twisted steel rods placed 12 in. on centers, top and bottom. This crossbracing at the top of the subfoundation piers, together with the 2-ft. penetration of each pier into the rock, at the bottom, makes a unit of the subfoundations.

[The investigations made into the stability of the foundations included investigation of the safety of the cylinder

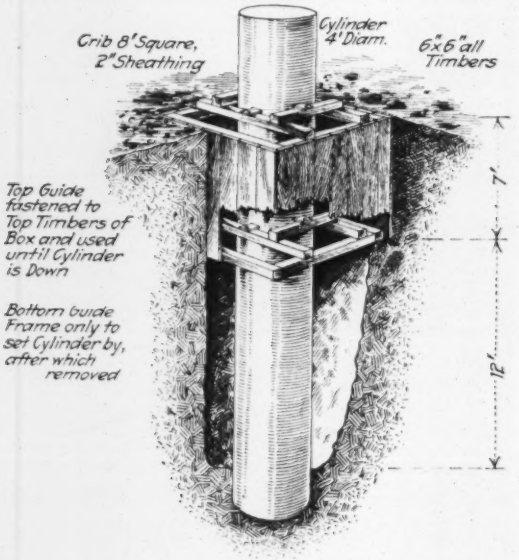

Crib 8' Square, 2" Sheathing
Cylinder 4' Diam.
6"x6" all Timbers
Top Guide fastened to Top Timbers of Box and used until Cylinder is Down
Bottom Guide Frame only to set Cylinder by, after which removed
7'
12'

FIG. 3. DETAILS OF CRIB IN WHICH CYLINDERS WERE SUNK

piers against crushing due to the total load, which showed that the total stress was about 500 lb. per sq.in. on a concrete that should be good for over 2,000 lb. per sq.in., an investigation of the lateral resistance of the piers acting as unsupported columns. The thrusts for which the piers were figured in lateral resistance were those due to the hydraulic pressure of the tidal range in the near-by river, which was considered to be transmitted through the earth-fill, and the weight of the fill exerting side thrust on the underlying ground and through that to the piers. It was found that the piers, acting as reinforced-concrete columns in bending, together with the resistance of the steel casing, were sufficient to withstand the side pressure, especially as the thrust was assumed to be transmitted from one pier to another through crossbracing.—Editor.]

Construction of the Subfoundations

From the deductions from the information obtained from the borings it was fully expected that it would be necessary to use air in working below the water level. The wet clay, however, was decidedly water-tight, and the only trouble was from water that came through the porous top sand layer. The equipment included a complete air-compressor plant with two 60-hp. locomotive-type boilers, an air compressor and an air lock. For setting the cylinders and handling the material there were two 10-ton stiff-leg skid derricks. The original plan was to excavate from the inside of the cylinders with a 2-ft. orange-peel bucket. The material was too stiff to make this plan successful, and the excavation had to be made with short-handled shovels, the material being lifted out in large buckets, for the handling of which two small derricks were later added to the equipment.

The general plan was first to make the initial excavation, then to set the cylinder and to sink them with the large derricks and to follow up with the small derricks for the excavation from the interior of the cylinders.

The method used in sinking a cylinder was first to sink an 8x8-ft. box or crib (Fig. 3) through the sand until the lower edge was resting in the clay. The crib was placed in position and sunk with an orange-peel bucket. Next, a hole was dug into the clay about 12 ft. deep. Guides were placed on the top and bottom timbers of the box and the first section of the cylinder, 27 ft. long, was placed. The weight of the cylinder section was sufficient to sink it into the clay and firmly fix it in position. It was then loaded, usually with five 2½-ton concrete blocks, which sank it until its top was level with the top of the box. The interior was then excavated by hand to 2 or 3 ft. below the cutting edge, when the second section, 13 ft. long, was placed in position and bolted. To sink this section required 20 tons of weight and jetting with a 2-in. jet around the outside of the cylinder. The inside was again excavated below the cutting edge and the third section added to the cylinder. This settlement generally required a load of about 30 tons and in some cases jetting for the full length of the cylinder around the outside. After the removal of the disintegrated rock, about 2 ft. thick, the final settlement of the cylinder to

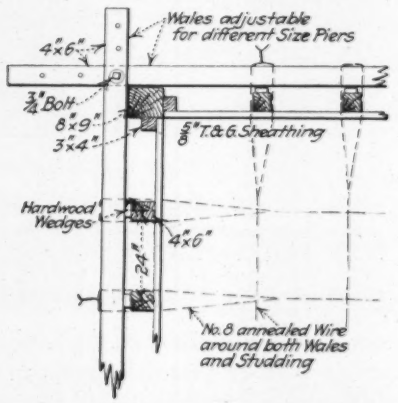


FIG. 4. CORNER SECTION OF FORMS FOR UPPER FOUNDATION PIERS, LINCOLN MEMORIAL

solid rock again required a load of about 30 tons and considerable jetting.

The jetting was the principal cause of the trouble with the water. It opened up a passage for water to seep down from the top along the exterior surface of the cylinder, and considerable quantities had to be removed before the final placing of the concrete. The next step was the excavation of the rock to a depth of 2 ft., which was done by blasting. The reinforcement was then placed in position.

The reinforcement was assembled on the ground and consisted of twelve 1¼- or 1-in. steel bars averaging 52 ft. long, spaced and tied to a ⅞-in. spiral-rod hoop rein-

forcing and placed by the derrick. The hoop reinforcement, with the fastenings, was not sufficiently rigid to prevent the assembled reinforcement from collapsing, and a method was developed in which the rods were bolted to three steel rings with a 1x6-in. section, one at each end and one in the center. These rings were left on the assembled units until the reinforcement was finally placed and wedged in the cylinders.

The concrete, a 1:2:4 gravel mixture, was placed in the cylinders with a bottom-dump bucket holding ½ cu.yd., which was lowered by a small derrick and tripped after the previous batch had been tamped with the loaded bucket.

The water was removed by bailing with buckets holding about 12 cu.ft. This method was found to be more rapid and economical than the steam siphon, which was used only to handle the water at moderate depths. The water was the cause of a great deal of trouble, and it is probable that it could have been much more easily handled with some one of the various kinds of portable water pumps.

Though the use of the skid derrick (see Fig. 2) is usual on work of this character, its selection in place of the derricks on wheels in this case was occasionally criticized. The principal factor in the handling of the job was the careful selection of capable foremen. The ease with which they could shift the heavy derricks, compared with the difficulties of some of the inexperienced foremen, was very instructive; and considering the trouble to be expected in taking care of the tracks and broken wheels, there is little doubt as to the correctness of the contractor's judgment in preferring the skid derricks.

The costs in the subfoundations varied considerably, due to the varying weather and other conditions, but a few average costs are given. The average cost of sinking and excavating a cylinder ready for reinforcement was as follows:

Overhead	$37.50
Plant equipment	99.50
Supervision and labor	207.50
Average cost of cylinder	188.00
Total	$532.50

Assembling and placing steel reinforcement averaged $13.45 per cylinder.

The total cost of the concrete in place per cubic yard, excepting the concrete materials but including overhead, plant and equipment supervision and labor, was $1.78 per cubic yard. The concrete materials cost $3.35 per cubic yard. Common labor was 20c. per hour.

Construction of the Upper Foundations

The construction of the upper foundations was similar to massive concrete work of the same character. The only unusual point was due to the fact that it was specified that certain piers be poured to a height of 37 ft. at one time.

The forms developed were adjustable to the various sizes of the piers and withstood the pressure with very little deflection. A corner section is as shown in Fig. 4. The waling pieces were spaced 2 ft. 6 in. on centers vertically, and the corner posts were made up in one 12-ft., two 10-ft. and one 5-ft. sections for convenience in handling and adjustment to the various heights. When the forms were removed, the top 5-ft. section was left in place to carry the beam and the floor forms.

Some of the 3-ft. 6-in. piers were poured in an hour and a half; and the only bulging was in places where it could be traced to the fact that, after the tie wires had been twisted up, they had been partially untwisted before the pouring of the concrete, to get the specified distance between the form walls. Once the untwisting of the wires was started, the pressure due to the concrete was sufficient to cause a considerably increased untwisting.

Some of the average costs are as follows: The total cost of building and stripping the forms for the piers and retaining walls was $0.11 per square foot; and for the beam, arches and floors, $0.22 per square foot.

The foundation is now complete and the superstructure being erected.

Chicago Street Widening

Two important and costly projects for street widening at Chicago are now going through the preliminary stages. They are for the widening of Michigan Ave. and of 12th St., and both are parts of improvements included in the "Chicago Plan," as reviewed in *Engineering News*, Mar. 11, 1915. Both projects include expensive bridges of interesting designs. The work is in charge of the Board of Local Improvements, of which C. D. Hill is chief engineer. John Ericson is city engineer.

The widening and improvement of Michigan Ave. is to extend north from Randolph St. to the Chicago River, in connection with a new bridge over the river and a new street to connect this with the boulevard system north of the river. The main part of Michigan Ave. is a fine broad boulevard, but for the three blocks north from Randolph St. it is a 66-ft. thoroughfare forming a "bottleneck" that carries the very heavy traffic between the boulevard and the Rush St. bridge. The Michigan Ave. bridge will be a double-deck bascule structure with inclined viaduct approaches. The upper deck will be for automobiles and pleasure traffic, and the lower deck (without sidewalks) will be for the heavy team traffic of the river-front streets.

The court proceedings for this improvement have been commenced. It will take probably the remainder of the year to secure a confirmation by the lower court and final approval by the Supreme Court of Illinois. Thus it is not likely that bids for any of the work can be received before 1917.

The 12th St. project provides for widening, improving and converting the street into a boulevard, all the way from Halsted St. east to the lake front (at Grant Park), a distance of over 2 mi. The present width is about 66 ft. This change will involve a long viaduct over the railways, and the Chicago River will be crossed by a 244-ft. drawbridge of the balanced-lever or direct-lift type. At present this street ends at Michigan Ave., beyond which it is blocked by railway property. The present railway station and terminal are to be abandoned, however, and rebuilt south of the extension of the 12th St. boulevard leading to the lake front.

The proceedings in the lower court are nearly concluded. It is considered most probable, however, that an appeal will be taken to the Supreme Court, which will prevent any work being started before October, 1916. This relates only to the work as far as Michigan Ave., the extension being a separate project.

Field and Office

Handling Pipes and Conduits in Sewer Trenching

The handling of water mains and the various utility pipes and conduits encountered in the excavation of sewer trenches is provided for very definitely in the new sewer specifications issued by the Board of Local Improvements, Chicago. These apply only to sewers built by special assessment. C. D. Hill is Chief Engineer of the Board; George C. D. Lenth is Assistant Chief Engineer of Sewers. The provisions, somewhat condensed, are:

The alteration of any utility or water main in the space to be occupied by sewers will be done without expense to the contractor.

Where excavating machines of the steam-shovel type are used for sewers 3 ft. in diameter or larger, any utility crossing the trench and any water main less than 16 in. in diameter will be removed and replaced without expense to the contractor; 16-in. and larger mains are to be left in place and supported at his expense.

Where excavating machines of the endless-belt type are used, all water mains will be maintained at the expense of the contractor. Where such machines are used for sewers less than 24 in. in diameter, he will also maintain all utilities; but for sewers of 24 in. in diameter and larger the utilities will be removed and replaced without expense to him.

Where sewer trenches are excavated in rock, each utility company will take care of its structures and the Bureau of Engineering will take care of water mains, provided that five days' notice is given before blasting is done and that special care is taken by the contractor.

Where the distance between centers of a new sewer and a parallel utility is not greater than the internal diameter of the sewer plus 4 ft. (or the external diameter plus 4 ft. for water mains), the utility (or main) will be maintained or removed without expense to the contractor. Where a water main is at a greater distance, the contractor will be liable for damage done to it. If the parallel utility is outside the lines of the trench and is left in place, the contractor, if directed, must leave sheeting or bracing in place, for which he will be paid.

Where excavating machinery is not used (except in rock), all utilities crossing the trench will be left in place and maintained at the expense of the contractor.

Where utilities or water mains cross a sewer trench and it is inadvisable to remove them, the contractor will be paid the additional cost of excavation under and around them by hand, in accordance with the following rule: In estimating the cubic feet of excavation the length of the section will be taken as equal to the length of the sewer trench occupied by the utilities plus 1½ times the depth of the trench (no deduction being made for space between adjacent utilities); the width of trench will be the internal diameter of the sewer plus 3 ft.; the depth will be the distance from the surface of the ground to 6 in. below the inside of the bottom of the sewer. The contractor will be paid a uniform rate varying with the extreme depth of the excavation from 2c. per cu.ft. for a depth of 6 ft. to 7c. per cu.ft. for a depth of 24 ft.

This rule applies in the case of excavating machines of the endless-belt type, which are used for the construction of sewers 24 in. in diameter or larger. Where sewers 3 ft. and larger in internal diameter are constructed by means of excavating machines of the steam-shovel type, $5 per lineal foot of trench is added.

Where sewers are constructed in paved streets and it is necessary to remove, alter or repair any utility or water main without expense to the contractor, the replacement of the pavement disturbed on account of such alterations outside of the limits of the sewer trench will be done without expense to him. For this purpose the width of the trench will be determined by adding to the internal diameter of the sewer an amount depending upon the thickness of the walls of the sewer. This amount will be 3 ft. for sewers 3 in. thick or less, 4 ft. for thickness up to 6 in., 5 ft. up to 10 in., 6 ft. up to 16 in. and 7 ft. for all sewers exceeding 16 in. in thickness.

Where excavating machinery is used, all service lines from utilities to buildings will be removed without expense to the contractor (if 48-hr. notice is given). All utility aërial equipment interfering with the operation of such machinery will also be removed; but if it interferes only with backfilling machinery, it will not be removed (except at his expense).

In regard to water service pipes, the contractor must ascertain for himself their existence and location. Where they are removed, cut or damaged in the construction of the sewer, the contractor must at his expense at once cause them to be replaced or repaired. In no case is he to receive extra compensation (in any form) for the removal, maintenance, lengthening, repairing or replacing or extra labor involved on account of water-service pipes encountered. He must not shut off the water-service pipe from any consumer for a period exceeding 6 hr.

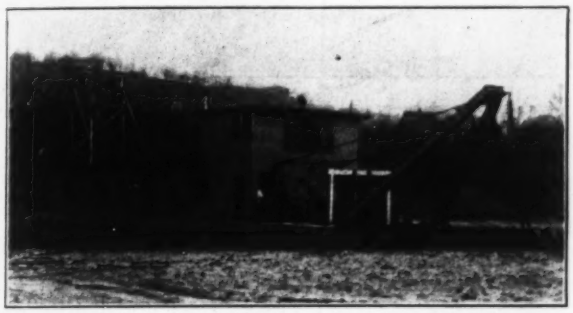
Whenever street-railway tracks in the street in which the sewer is to be constructed are moved, the contractor must provide proper planking and approaches for the passage of traffic across the street ahead of the excavation. At cross-streets he must (when directed by the engineer) provide bridges or other means of crossing.

Cutting Through House Services in Street Trenching—In machine trenching for sewer work in Houston, Tex., the inevitable destruction of house services that cross the line of the trench is made the sole responsibility of the contractor under a clause in the city's specifications covering such work. The city engineer must issue a written order before the contractor is permitted to injure any sewer, water or other pipe. This regulation is disregarded in practice, and the contractor goes ahead after simply notifying the property owners. In replacing these pipes a reinforced construction is used in order to avoid damage from settlement. The pipe put in to replace the damaged section is surrounded by an open wooden box of a width twice the outside diameter of the pipe and of a depth three times that diameter. The box extends 2 to 6 ft. back from the side of the trench and is filled with concrete after reinforcing bars are placed in the bottom. Thus a reinforced-concrete beam is formed around the pipe. The cost of this work is included in the cost bid per lineal foot of sewer.

Electric Maintenance Dredge on Kaw River

The small number of electric dredges in use in this country has recently been increased by an interesting craft purchased by Wyandotte County, Kansas (Kaw River Drainage Board, Kansas City), for cleaning up the Kaw River between levees for a section of 9 mi. from the river mouth. This is an important industrial district, and maintenance of a clear channel decreases flood troubles. Special interest attaches to this dredge, shown in the accompanying illustration, as one of the few receiving their power from shore by cable.

The dredge cost $62,000 and was designed and built by the Morris Machine Works, Baldwinsville, N. Y. The hull (90x32 ft. by 5 ft. 3 in.) is of wood, with steel trusses; there are two 24-in. wooden spuds. A 16-in. centrifugal pump is driven by a 750-hp. variable-speed induction motor, operated by a drum controller. The suction pipe is placed on a 36-ft. structural-steel ladder and has a steel agitator, or cutter head, driven by a 50-hp. motor. The drum hoist has a 25-hp. motor. There is also a 4-in. horizontally split general-service pump furnishing 400 gal. per min. against 140-ft. head. A 6-in. two-stage pump is driven by a 75-hp. motor to supply a



ELECTRIC SUCTION DREDGE FOR KAW RIVER

hydraulic giant on the bow of the dredge. A 2½-in. pump driven by a 2-hp. motor furnishes cooling water for the electrical equipment. Electric current is delivered along the bank by a 6,600-volt line; it is stepped down to 2,300 volts and led to the dredge by a submarine cable.

Block Street-Number System Completed in Utica

A block system of street numbers for the entire City of Utica, N. Y., was completed on Feb. 2, 1916, when the city council adopted the renumbering plans of the city engineer, Joseph Kemper, for the section of the city west of Genesee St. The city engineer's plans for the eastern section were adopted Feb. 4, 1914, after 17 years' agitation.

Many difficulties were encountered, owing to the irregular arrangement of streets, as shown in the accompanying sketch, and a few arbitrary steps were required in the heart of the city. So-called "rectifying ordinates" were established, beyond which the normal conditions prevailed (these are indicated by *R* in the sketch). Some little dissatisfaction was found with the radical change at first, but the benefits of the plan quickly won recognition. It was immediately adopted by the electric, gas, water and express utilities and by the post office, and taken up with favor by most of the people.

NEW STREET NUMBER PLAN, UTICA

The new numbers were furnished property owners free and were attached by the city renumbering forces. Nickeled brass figures costing 3½ to 4c. each were used. A number of people were disinclined to permit their dwellings to be renumbered (and they could not be compelled), until advised that all the utility services would use the new system and that it was to the advantage of householders to do the same.

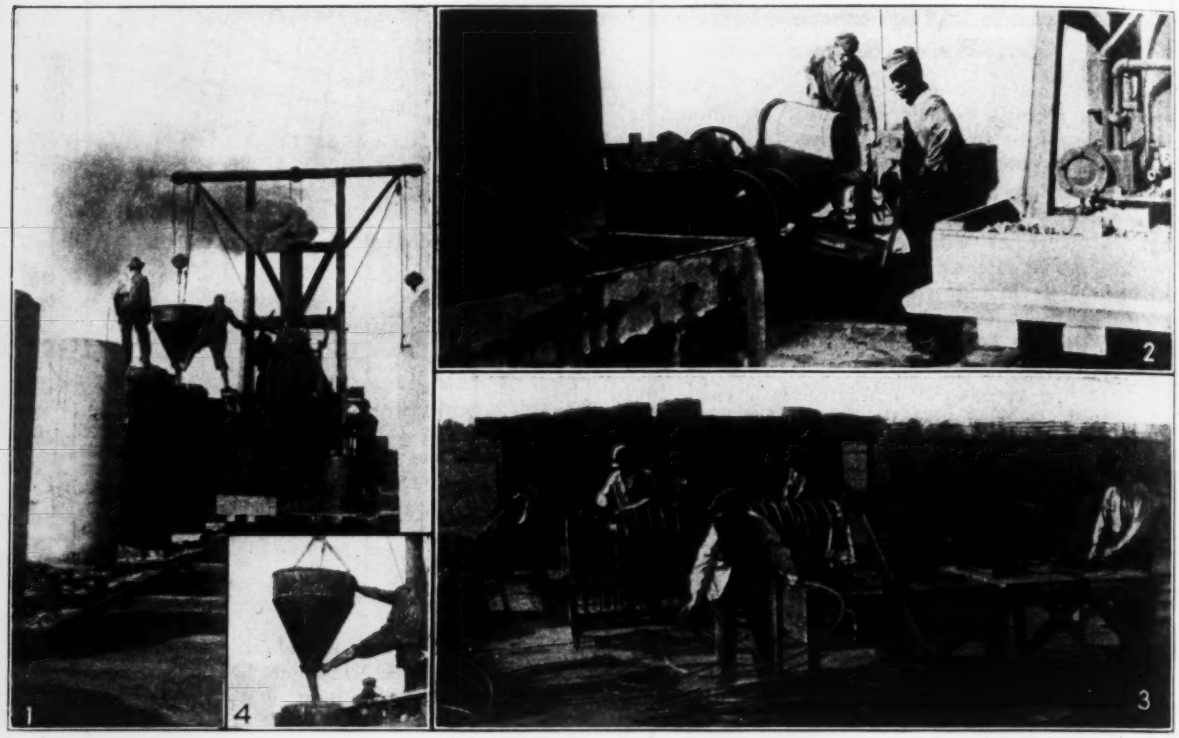
The old city directory showed for every street all the numbers and residents thereon between intersecting streets. Sets of these lists were pasted on cards and the new numbers added also. This has proved of immense service in referring from new to old numbers for given premises.

Making Lock-Joint Concrete Pipe at Dallas, Tex.

About 4 mi. of the force main from the pumping station of the Dallas, Tex., sewage disposal works to the Imhoff tanks is to be of concrete pipe 4 in. thick and 36 in. in diameter. This pipe line has been guaranteed by the makers, the Lock Joint Pipe Co., New York City, to have a leakage of less than 22,000 gal. in 24 hr. under a pressure of 30 lb. per sq.in. The pipe is cast in 8-ft. lengths and has patented lock joints according to the Meriwether system.

The manufacturing plant for this pipe is laid out in a level field some distance from the Trinity River, about halfway between the two ends of the main. Through the middle of the yard is a traveling crane, or T-frame, mounted on a 6-ft. gage car and track. Square concrete bases for the steel pipe-forms to rest on are planted in the ground on each side of the track, about 6 ft. apart.

At one end of the yard are two "Little Wonder" concrete mixers (gasoline-engine driven) of ⅛-cu.yd. capacity each, one on each side of the crane track. Fig. 2



FIGS. 1 TO 4. PLANT FOR MAKING LOCK-JOINT CONCRETE PIPE FOR SEWER FORCE MAIN, DALLAS, TEX.
Fig. 1—Traveling crane and bucket. Fig. 2—Concrete mixer and grout-mixing box. Fig. 3—Making hoop reinforcing units Fig. 4—Special bottom-dumping bucket

shows one of these mixers and its position with respect to the crane. In the left foreground of Fig. 2 is the mixing box for the 1:1 grout used in the bells of the pipe.

At the other end of the yard the reinforcement is fabricated. The straight bars, cut to proper length, are run through rolls and bent approximately to the correct radius. They are then passed to tables laid out with templets, where the bending to accurate dimensions and the wiring of the ends of the hoops together are done. The hoops are then passed along to the reel-like structure shown in Fig. 3, where they are formed into pipe units. They are correctly spaced by dropping into four accurately notched longitudinal bars.

All Work Controlled by Templets

In making up the reinforcement and in all the other pipe-making operations, everything is done to templet. The superintendent has so arranged the procedure that no workman needs, or is even allowed to have, a foot rule. The final operation in making the reinforcement units is performed by a workman after the bars are taken off the reel. It consists in making one or two wire loops halfway up the hooped cylinder, to keep it from collapsing longitudinally when placed in an upright position.

The copper for the joints comes in sheets. It has to be run through three hand-operated crimping rolls, to give it the U-shape crimp for an expansion joint. The plate is then punched at intervals by hand, to furnish a bonding surface for the concrete. The copper plates are bent around a wooden templet and soldered to the correct radius. The wire-fabric hoop reinforcement for the bells of the pipe is similarly shaped and soldered to the correct radius.

The process of pouring the pipe is as follows: The bell end of the pipe is down, and two pails of 1:1 grout are first poured to make the bell. On top of the inside

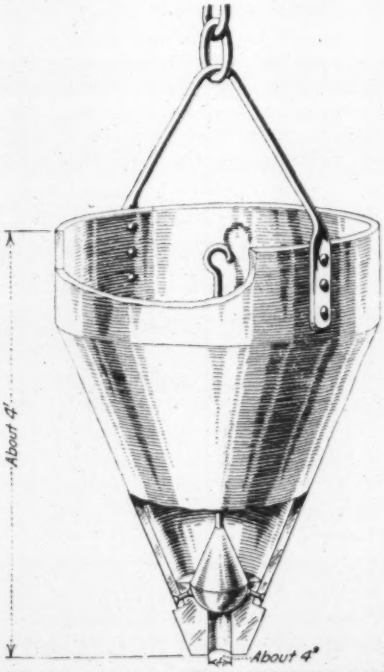


FIG. 5. DETAIL OF BOTTOM-DUMPING BUCKET, LOCK JOINT PIPE CO.

shell is a round steel plate that serves the double purpose of holding the shells in proper alignment and of forming the dumping platform for the concrete. Obviously, a bottom-dumping bucket is required. The one shown in the illustrations Figs. 1 and 4 is an entirely new one, first used on this work. It was invented and is patented by J. C. Mitchell, Lock Joint Pipe Co., who is superintending the manufacture of this pipe.

The principle of the bucket is shown in the sketch, Fig. 5. The shell is of riveted sheet steel, cone-shaped, with a cylindrical top. Its capacity is about ⅜ cu.yd. The patented feature is the valve and dumping device. As anyone knows who has worked with concrete, it is very difficult to empty half a cubic yard of concrete through a 4-in. hole in the bottom of a bucket, on account of the arching of the material over the opening. The bucket shown accomplishes this purpose and also controls the flow of the concrete, so that as much or as little as desired may be dumped or the flow cut off.

How the Special Pouring Bucket Works

The bucket is filled with the valve and stem in place. The upper half of the valve, or plug, is cone-shaped, and the lower half is hemispherical and fits snugly into a hollow hemispherical casting. A hand-operated lift line is attached to the valve stem, and by lifting, the flow of concrete is started and controlled. Any tendency of the material to arch over the opening is prevented by a slight tightening and slacking on the lift line. The concrete runs out over the top plate of the form and over its edges into the shell in a steady, uniform flow. As soon as a bucket is emptied, a man with a long-handled wooden paddle tamps the concrete in the forms. At the mixers the buckets are placed in pits while being filled.

When the concrete has sufficiently set, a steel sling is fastened around the middle of the sections of the pipe, and they are picked up and laid on their sides on wooden runways, about 50 ft. long, extending at right angles to the crane track on either side. The sections of pipe are rolled to the far ends of these runways, where they remain to finish curing. The ends of the runways are sufficiently elevated so that the sections of pipe may be rolled from them directly upon special wagon bodies provided for haulage to different parts of the work.

Underground Sewage-Pumping Station, Abilene, Kan.

What appears to be an ornamental traffic signal and lamp post is shown in the accompanying illustration, Fig. 1. It is the motor housing of an automatic sewage-pumping station in Abilene, Kan. The conditions are shown in the profile, Fig. 2. Originally the motor and pump were located in the manhole, but the damp atmosphere and the fact that the creek had a habit of occasionally rising just enough to flood the manhole, putting the apparatus out of business at the times it was most needed, led to another solution of the problem.

The motor is now housed in a sheet-metal structure, shown in Fig. 1, which is 30 in. wide at the base and about 8 ft. high, built on a concrete base on one side of the manhole. The motor is about 8 in. above the street level. It is a 5-hp., 3-phase, 220-volt motor with vertical shaft, driving a 120-gal. per min. centrifugal pump (2-in. suction) at 800 r.p.m. It starts automatically when the sewage is 8 ft. above the bottom of the manhole and stops automatically before the suction pipe is uncovered. It runs about 4 hr. per day. The motor and pump cost $260 and the house and lamp $75.

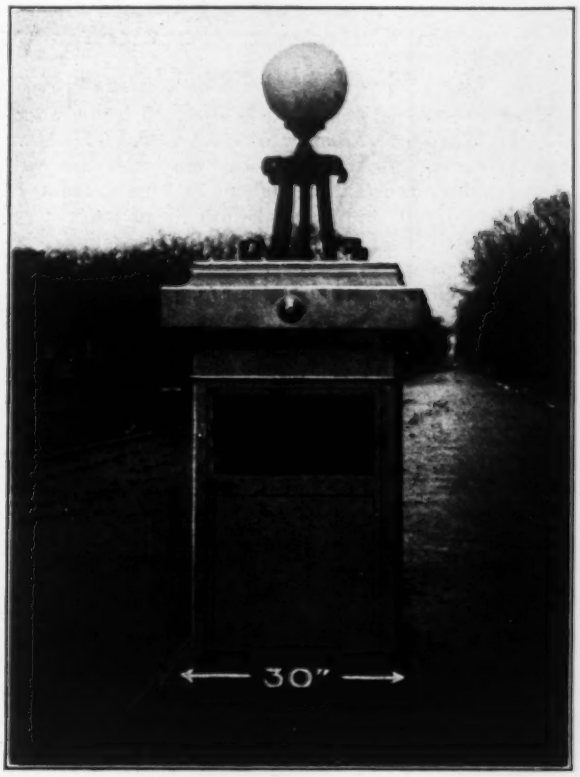


FIG. 1. SEWAGE-PUMPING STATION AND TRAFFIC SIGNAL POST

The pumping station is located at a street intersection, and the projecting motor housing was therefore made into a traffic signal. There is a white light on top, and red bull's-eye lights face traffic in each direction. Kenyon Riddle, City Manager, is the designer.

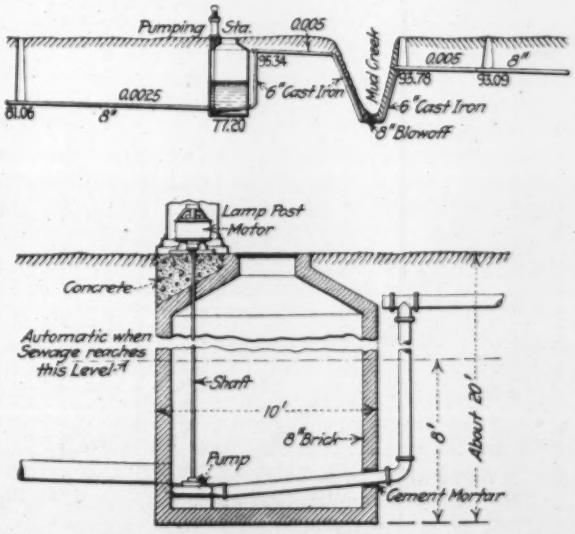


FIG. 2. LOCATION SKETCH AND DETAIL SECTION OF SEWAGE-PUMPING STATION

Design Charts for Open Flumes with Catenary Section

By Ernest L. Robinson*

When a suspended flume is to be designed for pure tension, the hydrostatic catenary must be used. This is an unusual curve. Its mathematical properties are well known (tension constant throughout its length; radius of curvature inversely proportional to depth of water); but computations cannot be made by ordinary methods, because the equation of the curve can be written only in terms of the elliptic integrals. On this account it has been customary to make designs by graphic analyses based on the known properties of the curve. To avoid these methods, the charts below have been plotted from the equation of the curve, using tables of elliptic integrals.

*Westinghouse Church Kerr & Co., New York.

Figs. 1 to 4 are for use when the curve extends to the water surface—that is, when the curve is complete. The superposition of these charts shows several interesting facts.

For any particular area of flume section, (1) the tension in the sheet is a minimum when the width is 1.20 of the depth; (2) the wetted perimeter is a minimum and the mean hydraulic radius a maximum when the width is 1.92 of the depth; and (3) taking the amount of material in the sheet as proportional to the product of the tension and the wetted perimeter, this quantity will be found to be a minimum when the width is 1.47 of the depth.

The carrying capacity of an open flume is proportional, according to the Chezy formula, to the product of the area and the square root of the mean hydraulic radius. For any particular carrying capacity the amount of material in the sheet will be found to be a minimum when

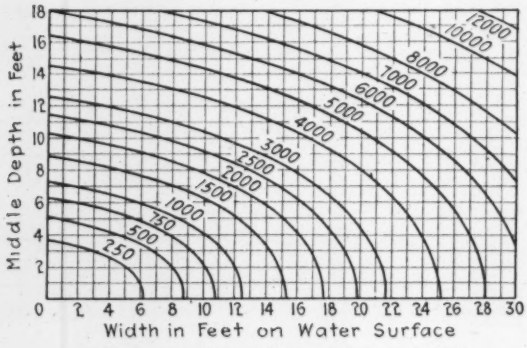


FIG.1 TENSION IN POUNDS PER LINEAL FOOT

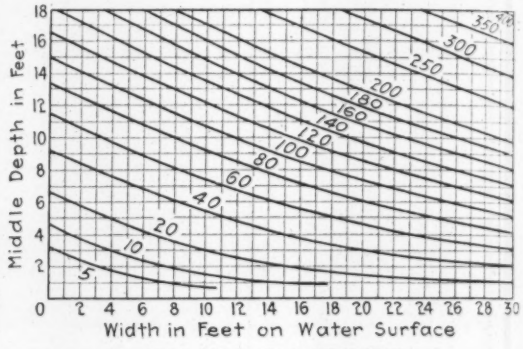


FIG.2 AREA IN SQUARE FEET

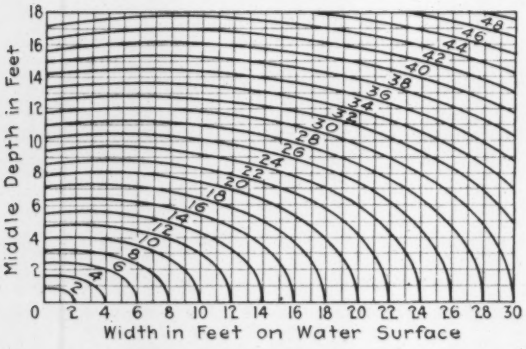


FIG.3 WETTED PERIMETER IN FEET

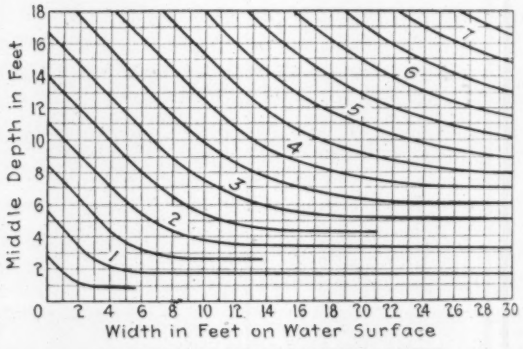


FIG.4 MEAN HYDRAULIC RADIUS IN FEET

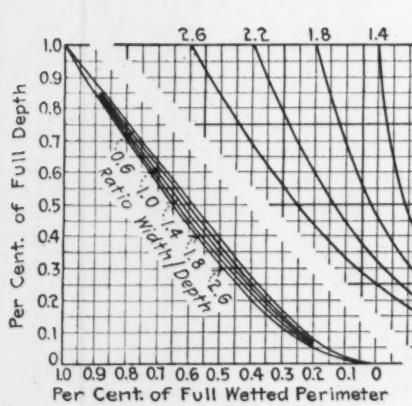


FIG.5

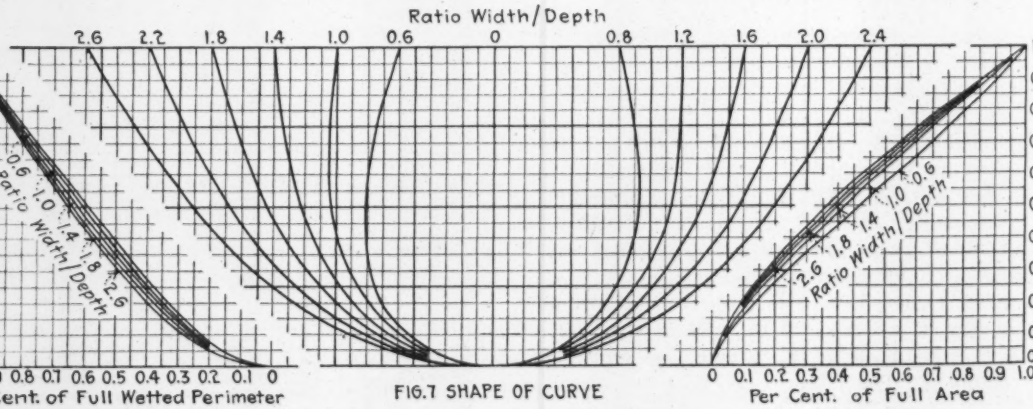


FIG.7 SHAPE OF CURVE

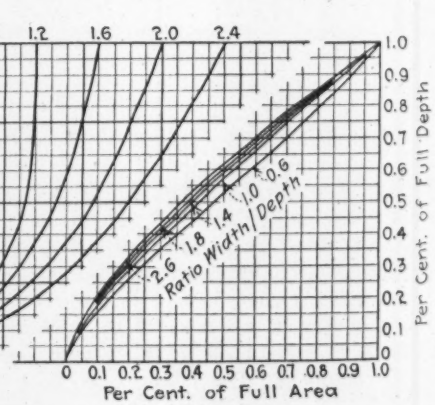


FIG.6

CURVES FOR DESIGNING HYDRAULIC-CATENARY FLUMES—E. L. ROBINSON

the width is 1.55 of the depth. A design may be called economical when the ratio of width to depth lies anywhere between 1.3 and 1.9. Between these limits the amount of material corresponding to a given capacity does not vary more than 3%.

Fig. 7 shows the actual shape of the hydrostatic catenary for various proportions of width and depth. Figs. 5 and 6 are for use when the curve does not extend to the water surface and is therefore incomplete. In this case the properties of the section can be computed as illustrated herewith. Suppose a rectangular flume 16 ft. wide and 3 ft. deep has a catenary bottom 7 ft. deep below the rectangular part, making a total depth of 10 ft. First, it is necessary to find of what complete catenary this bottom curve is a part. At 0.7 of the full depth of the water the width of the flume is 1.6 of the full depth. Looking at Fig. 7 and measuring 0.7 up from the bottom and then half of 1.6, or 0.8, on each side of the center line, it is found that the curve marked 1.8 exactly meets this prescribed condition.

Hence, were the curve complete, its width at the water surface would be 18 ft. Fig. 1 gives the tension as 4,300 lb. per lin.ft. Fig. 2 gives the area of the complete curve as 134 sq.ft., and Fig. 3 gives the wetted perimeter as 29.4 ft. For 0.7 depth, Fig. 5 gives a wetted perimeter of

$$0.79 \times 29.4 = 23.2 \textit{ ft.},$$

and Fig. 6 gives an area of

$$0.61 \times 134 = 82 \textit{ sq.ft.}$$

Including the rectangular section, the total area of the flume is 130 sq.ft. and the mean hydraulic radius 4.45 ft.

The equation of the hydrostatic catenary is mathematically the same as that given for the elastic curve of a deflecting column on p. 1109 of *Engineering News* for June 10, 1915. Similarly the formula for true length of a deflecting column gives the wetted perimeter of the catenary. The diagrams of the elliptic integrals there printed are equally useful for solving the formulas on which Figs. 1 to 7 of the present article are based.

Cost of Hauling Gravel by Team and by Tractor*

By O. L. Kipp†

The information here given is derived from the gravel checkers' records on five team-haul jobs totaling 22 mi. of road graveled and one tractor-haul job covering 3.6 mi. of road graveled. The gravel was placed at the rate of 15 cu.yd. per 100-ft. station.

On the team jobs 1½-yd. loads were hauled uniformly. The team wagons were loaded by hand, with a maximum of two shovelers. The accompanying table gives the records and shows also how the hauling cost could be lowered if the time of loading were reduced to 12 min. and 6 min. per load. The figures warrant these conclusions, for in job. No. 2, on the ½- to 1-mi. haul, the cost was 22.9c. with 8.7% loss of time at the pit; on the 1- to 1½-mi. haul the cost was 29.4c., as compared with 29.8c. estimated. On the 1½- to 2-mi. haul of job No. 3 the cost was 38.4c., as compared with the estimated 38.5c.; and on a 2.95-mi. haul the cost was 67c. with a 12.3% loss of time, as compared with the estimated cost of 65c.

Efficiency in team hauling and consequent low cost are largely dependent upon, and might easily be secured by, obtaining the maximum efficiency in loading. This problem is by no means as easy as that of the hauling, for many varying conditions are encountered. The total loading and hauling cost on the various jobs was figured to provide for the shovelers actually employed and $5 per day additional for the general superintendence of a foreman or the contractor.

The loading costs vary from 7 to 25c. per yd., the lower figures being too low on account of the teamsters acting as shovelers while waiting to get into the pit and the highest figures being boosted on account of an excessive amount of frost and firewater and also poor supervision. The lowest job average for loading was 9c. per yd., due largely to favorable pit conditions. For average Redwood County pits 10 to 15c. per cu.yd. should cover loading by hand. Whether or not some mechanical loader would be able to reduce this item, I am unable to state.

The failure to solve successfully this mechanical-loading problem contributed in a large measure toward increasing the figures for gravel hauling by tractor. The outfit consisted of a Holt caterpillar gasoline tractor with seven Troy 3½-yd. reversible spreader wagons, a 50-yd. storage bin and a belt-conveyor loader.

When the first train was loaded, it was found that the tractor would not pull more than two cars over a short sharp pitch at the railway crossing on the most direct route. Experiment showed that four cars could be hauled across fields to the top of a short pitch about ¾ mi. from the pit and that, by doubling back for the remaining three cars, a train of five cars could be made up and drawn the remaining distance of 2¼ mi. About 1,365 cu.yd. was handled in this way over an average distance of 3 mi., or a total of 4,125 cu.yd.-mi. at the average rate of 129 cu.yd. per mi. per day. With $20 per day to cover operation, interest and depreciation, the rate was 15.4c. per cu.yd. per mi. for the hauling.

From the next pit was taken 1,584 yd. to a distance of 1 to 3.6 mi., making a total of 3.422 cu.yd.-mi. There were no grades over 2%, and with an average of 142 cu.yd.-mi. per day the cost was 14.1c. per cu.yd.-mi. On several days the total was 216 cu.yd.-mi., which would be at the rate of 9.2c.

The advantage in favor of the tractor would have been greater with a more powerful machine. The capacity of the train was reduced also by the insufficient capacity of the loading equipment. With power to pull six cars and with a trainload of gravel always ready when the train arrived at the pit the record of 9.2c. per cu.yd. per mi. could have been maintained throughout the job. But the outfit cannot make money while waiting to be loaded.

A bin of 25 to 30 cu.yd. capacity must be provided and must be easily transported from pit to pit. This portable feature is essential for the loading apparatus also. In this case the cost of taking down, moving and reërecting the bin amounted to fully 10c. per yd. of gravel handled. The belt conveyor may be successful on a level grade or on a slight incline, but raising the gravel about 30 ft. vertically was beyond its practical range. The cost of loading with this apparatus was 25 to 30c. per yd., which with the cost of moving the bin makes a total

*Abstract of a paper read at the annual meeting of the Minnesota Surveyors and Engineers Society, St. Paul, Minn., Feb. 10-12.

†District Engineer, State Highway Commission, Redwood Falls, Minn.

COST OF HAULING GRAVEL WITH TEAMS*

Haul	0-½ Mi.			½-1 Mi.			1-1½ Mi.					1½-2 Mi.				2-2½ Mi.	2½-3 Mi.
Job No.	1	2	5	1	2	5	1	2	3	4	5	1	3	4	5	3	3
Total loads hauled	407	475	482	327	1,571	364	606	525	898	44	746	312	873	434	198	337	267
Average No. teams hauling	7.2	5.2	4.5	9.6	7.0	9.0	6.5	7.6	7.0	6.0	8.7	6.4	7.5	5.2	4.6	8.0	7.2
Average loads per team-day	12.1	14.0	9.45	9.75	11.67	7.35	7.0	9.1	7.55	7.33	6.0	5.4	6.93	6.73	5.35	4.6	4.0
Load miles per team-day	4.24	4.62	2.83	7.31	8.75	5.51	8.75	11.38	9.44	9.16	7.50	9.45	12.13	11.78	9.36	10.35	11.0
Per cent. time dumping (5 min. per load)	10.0	10.9	7.8	8.1	9.7	6.1	5.8	7.6	6.3	6.1	5.0	4.5	5.8	5.6	4.4	3.8	3.3
Average time in pit per load	30.6	25.0	46.0	26.6	16.5	46.7	30.7	11.0	24.4	24.5	45.0	36.0	11.5	14.2	37.2	36.0	35.1
Per cent. time in pit per load	61.7	58.3	73.3	43.2	32.0	57.2	35.9	16.7	30.7	32.9	45.0	32.5	13.3	15.9	33.2	27.2	23.4
Per cent. time required for loading at 12-min. per load	24.2	28.0	18.9	19.5	23.3	14.7	14.0	18.2	15.1	14.7	12.0	10.8	13.9	13.5	10.7	9.2	8.0
Per cent. time actually lost in pit	37.5	30.3	54.4	23.7	8.7	42.5	21.9	.....	15.6	18.2	33.0	21.7	.....	2.4	22.5	18.0	15.4
Average No. teams at pit	4.5	3.0	3.3	4.1	2.2	5.1	2.3	1.3	2.2	2.0	3.9	2.0	1.0	0.8	1.5	2.2	1.7
Hauling cost per cu.yd., cents	21.9	19.0	28.3	27.3	22.9	36.3	38.1	29.4	35.3	36.4	44.4	49.4	38.4	40.0	50.0	58.0	66.7
Load. and hauling per cu.yd., cents	29.9	28.0	38.3	34.3	30.9	46.3	49.1	39.4	47.3	51.4	56.4	66.4	51.4	60.0	75.0	76.0	89.7
Contract price per cu.yd., cents	45.0	39.0	35.0	60.0	50.0	45.0	70.0	65.0	65.0	60.0	65.0	85.0	80.0	75.0	80.0	107.5	122.5
Spreading cost per cu.yd., cents	2.0	2.25	3.75	1.75	2.00	2.50	3.75	2.50	3.0	3.75	3.0	5.0	3.25	5.0	6.25	4.5	5.75
Hauling per cu.yd.-mi., cents	73.0	57.6	94.3	36.4	30.5	48.4	30.5	23.5	28.2	29.1	35.5	28.2	22.0	22.8	28.5	25.8	24.3
Hauling per cu.yd.-mi. with 12-min. for loading, cents	43.0	43.0	43.0	27.8	27.8	27.8	23.8	23.5	23.8	23.8	23.8	22.0	22.0	22.0	22.0	21.2	20.6
Hauling per cu.yd.-mi., with 6 min. for loading, cents	.....	.....	34.1	24.5	.....	.....	21.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hauling per cu.yd., with 12 min. for loading, cents	.....	13.5	.....	.....	20.5	.....	29.8	.....	.....	.....	.....	.....	38.5	.....	.....	.....	.....

* The figures in this table are based on 25c. per hr. for man alone and 40c. per hr. for man and team.

loading cost of 35 to 40c. per yd. With proper equipment this should not exceed 10c. per yd.

There are other features in favor of tractor hauling. By applying the gravel in two courses with a tractor the gravel is rolled without additional cost, and the road is ready for travel as soon as the gravel is applied instead of a month or more later, as with teams. By loading into a bin, thence to wagons and thence to the road, an efficient mixing of the materials is obtained instead of having one load with good gravel with a fair amount of binder followed by a load of sand with no binder.

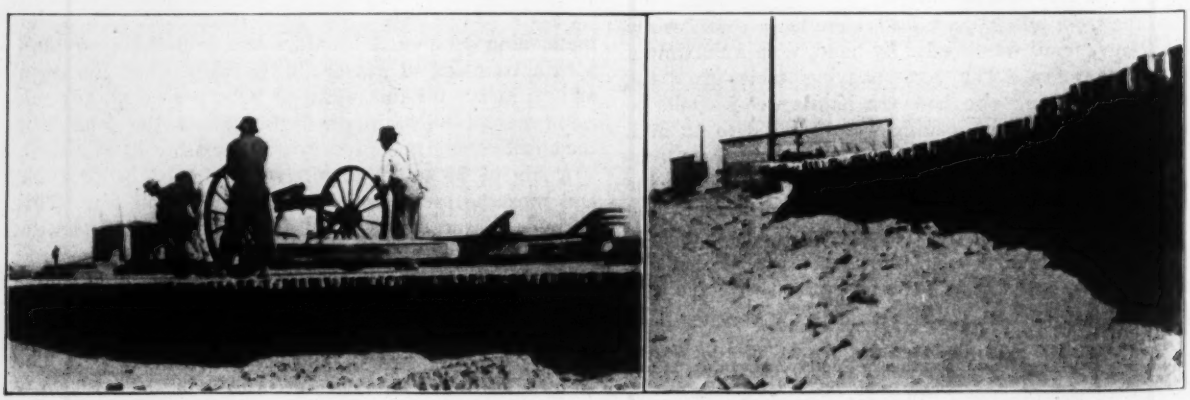
NOTES

Full-Tempered Hand Punches Are Dangerous—A warning to users of hand punches is sounded by C. D. Melhuish, Jamestown, N. Y., of the insurance firm of Slone, Melhuish & Co. He says: "In investigating reports of accidents we find many hand punches in use in which the temper is the same throughout the entire length of the tool, which makes it extremely dangerous to the operator because of its liability to chip. Would you care to call the attention of both the manufacturers and buyers of these tools to the advisability of annealing the hammer end of the tool?"

An Ocular Demonstration of what a well-grouted brick pavement will stand, without any foundation whatsoever, is shown in the accompanying illustrations. These pictures show a part of the washed-out sections of the boulevard that follows the famous Galveston (Tex.) sea wall. The damage was done in the great storm of last summer. The pavement is of repressed brick with grouted joints and, except for the two portions where the water and waves got behind and under the pavement, is in almost perfect condition today, notwithstanding the fact that the bricks are laid on the sand without a foundation of concrete or macadam. The cantilever slab shown in Fig. 1 projects fully 5 ft. at its widest point without support. The picture shows a two-wheel truck loaded with a reinforced-concrete sheet-pile, which must have weighed nearly 1,000 lb., passing over this cantilever. In fact, this part of the pavement appears to have been chosen to cast concrete piles. Fig. 2 gives some idea of the length of the cantilever.

Filling for an Earth Dam at Paris, Ill., was done by dumping wagon loads far apart instead of close together. The loads were about 12 ft. apart in rows 5 ft. apart along the line of the dam. All teams dumping within 150 or 200 ft. of the end farthest from the borrow pit traveled to the end of the row before turning. Other teams turned as soon as their wagons were dumped. The loads were leveled and spread with a grader. This method of work was described in a paper presented by George C. Habermeyer before the Illinois Society of Engineers. He thought few contractors would object to dumping the loads far apart after they have tried it, as a better driveway is secured and the grader is not likely to be very busy.

Old Concrete Found Good—Concrete in the New York subway, placed 10 to 15 years ago, has proved to be in very good shape in those locations where reconstruction work has made it necessary to cut into it, according to a paper by Robert Ridgway, Engineer of Subway Construction, read before the American Concrete Institute in Chicago. Some of the reconstruction work involved the cutting out of the original concrete in many places. Mr. Ridgway says that it is a satisfaction to state that there has been no evidence of any disintegration of the old concrete from electrolysis or other causes. Two pieces of concrete from the lining of the Park Ave. tunnel were cut out within the past few months, shaped into a 6x6x12-in. prism and tested for compression. One sample failed at 3,950 lb. per sq.in.; the other did not fail at the capacity of the machine, about 4,000 lb. per sq.in. This concrete was 13 years old, and the samples were selected as being rather below the average quality of the concrete being removed in the vicinity. In driving the shields for the tunnel which passes under the East River from Old Slip, Manhattan, to Clark St., Brooklyn, the Manhattan shields encountered the concrete foundation of the bulkhead wall that was constructed in 1905. This foundation was in the form of concrete deposited in salt water in burlap bags and was found to be in excellent condition. The burlap of the bags was intact in places, and the general appearance of the material was that of mass concrete placed in the dry.



FIGS. 1 AND 2. BRICK PAVEMENT WITHOUT FOUNDATION, GALVESTON, TEX.

Editorials

Why Indiana's Public Service Commission is Popular

Pleased with the reduction of local water-meter rates by the Indiana Public Service Commission, the Terre Haute *Tribune* reviews savings in public-utility charges in the state, which have been brought about since the commission came into full swing. The *Tribune* figures out a saving of $500,000 a year by a net annual expenditure of $73,000 thus:

> Among the amounts directly saved to the consumers, as shown by the records and as pointed out by Judge Duncan, were these: Indianapolis, gas, $125,000 a year; Indianapolis, light and heat, $233,000; South Bend and Elkhart, light, $45,700; Terre Haute, water, $30,000; Evansville, gas, $25,000; La Fayette, light, $12,000; Richmond, water, $10,000; New Albany, light, $12,000. The most important reductions in all cases have been to small users.

The commission is credited with other savings, not the least of which have been human lives. The rulings of the commission are claimed to have been fair to the companies, so that new capital is being invested in public utilities in Indiana. Moreover, the commission is declared to be absolutely nonpartisan. No wonder it is popular. Other commissions will please copy—in so far as they are not already in the same category.

Water-Power Legislation in Congress

A very large body of engineers, contractors and manufacturers are deeply interested in the question whether Congress will at the present session pass legislation that will make capital willing to invest in enterprises for water development. It is stated on the best of authority that work on water-power developments amounting to a million horsepower will go forward immediately if Congress enacts satisfactory water-power legislation at the present session. It is probable that several times that amount will be undertaken within the next few years, in the event of such legislation.

The Ferris bill, which passed the House Jan. 8, provides for 50-yr. leases by the Federal Government of rights to develop water power in which use of the public lands is involved. The Shields bill, which passed the Senate Mar. 8, provides for leases of the same length of time of the right to develop water power on navigable streams. Each bill provides for control by the Federal authorities, to the end that the work may be carried out on proper engineering lines and with a view to a broad development and full protection to all other interests concerned in the use of the water. Each bill further provides that the rates, etc., charged for power developed shall be subject to regulation by proper state authorities, or by the Interstate Commerce Commission where the power is transmitted across state boundaries.

Of course, the final form that each of the bills may take is still to be determined in its passage through the other house and probably in final discussion in conference committee; but it is very greatly to be desired in the public interest, not less than in the interest of the many thousands whose employment and business are at stake, that each of these bills shall become law at the present session of Congress and shall be enacted in such form that capital may again be attracted to water-power investments.

From the point of view of true conservation, whenever power can be generated by falling water instead of by burning coal or oil, we are saving stored-up mineral fuel that once burned, can never be replaced. This is not a problem of the remote future, but of the present. The demand for kerosene, gasoline and other products of petroleum is again increasing faster than the supply. Under steam boilers millions of gallons of oil are being burned that in all probability will be sorely needed, a very short time hence, as a fuel for motor trucks and other vehicles.

The conservation movement, however, has been to a large extent diverted from this original and most important end and made to stand for opposition to the giving away by the Federal Government of valuable privileges. The importance and value of this movement also are not to be denied. The policy of giving away the title to public lands, mines, forests, water-power sites and other valuable gifts of nature to the first person who chose to grab them was a policy that had to be abandoned.

In its place there is substantial agreement that these gifts of nature should be exploited under conditions that will protect the rights of the public while at the same time safeguarding the rights of those who invest their money in the development of these natural resources.

The opposition to the water-power bills in Congress appears to be due chiefly to those who, through lack of knowledge of the conditions under which water power is developed, believe that every water-power site is a profit-yielding gold mine and that, when the Government leases to some party or company the right to develop a water power, it should receive a substantial rental.

In the bills previously referred to some return is, indeed, provided for. The party developing water power by a dam on a navigable stream, for example, must build at its own expense canals and locks for the use of boats. If it uses surplus water at a dam built by the Government, it is to pay for it at a rate to be fixed by the Secretary of War.

If it is attempted, however, to incorporate in the bills provision for a large rental or heavy tax for a power site, the development of power under the bills will be strictly limited. It must not be overlooked that for the development of a profitable water-power business there are necessary, not only an available site, the legal authority to use it and improve it and other real estate for transportation lines, rights-of-way, etc., but in addition a large amount of engineering and business ability. And this last is just as necessary as the first. For the lack of this last, a great number of water-power enterprises scattered

all over the country have yielded a loss instead of a profit to those who invested in them.

The conditions under which water-power development is to be made possible must include not merely a return on the capital invested at current interest rates and a return in addition sufficient to compensate for the risk attendant on every water-power enterprise, but also a profit sufficient to attract the business and engineering ability requisite to obtain the best results possible.

If the pending bills go through in such form as closely to limit the possibilities of profit, the result will be the development of only a few enterprises, where conditions are exceptionally favorable and risks are small. If, on the other hand, the legislators so frame the bills as to give a reasonably free hand to water-power enterprise, work will certainly go forward on a large scale. There is no room for doubt that the latter result rather than the former is to be sought in the public interest.

Deceiving the American Society of Civil Engineers

An idea is being disseminated among members of the American Society of Civil Engineers remote from New York City to the effect that the proposed removal of the society's New York City headquarters from its present house to the Engineering Societies' Building is a change that really means the merger or affiliation of the society with the other national societies. That such an idea is wholly groundless was explained in an editorial discussing the pending proposition in our issue of Feb. 17. We are now able to present in exact terms the charge which has been made and which we are informed has been sent to every local organization of members of the American Society of Civil Engineers outside of New York City. The charge is *verbatim* as follows:

> An invitation has been extended to the American Society of Civil Engineers to enter "the United Engineering Society as an additional founder society." This invitation itself shows that the destinies of the "founder societies" is largely if not wholly controlled by a superior authority; and the fact must not be overlooked that the relationship which exists between the United Engineering Society and the founder society which gives the former authority over them has not been presented in detail to our members.
>
> Suppose we become an "additional founder society" and desire to put before the public a measure which we have conceived and which we deem important. It must have the sanction of the United Engineering Society, representing a majority of the founder societies, which can prevent action, or, if approved, the United Engineering Society would stand before the public as the sponsor of the measure. This illustration applies equally to all of the founder societies.
>
> The sacrifice of independence and individuality most certainly would go beyond property ownership. We have gained an enviable and honorable position in public esteem without the aid of other societies, and membership in our society is accepted as a synonym for integrity, ability and efficiency. We have consistently conducted our affairs in such way as to prove that we are the champions of those virtues and have won our way as the leaders of movements looking to the uplift of the engineering profession.
>
> To turn over the laurels won during 64 years of consistent effort is indeed a sacrifice. It must be evident that, if the invitation to join the founder societies is accepted, we must surrender the prerogative of leadership which we have held so long and in the future be content to serve under the banner of the United Engineering Society.
>
> If we do accept the invitation, future national or other movements for the benefit of the profession will be headed by the United Engineering Society and our share in the work will be merely auxiliary thereto, the ultimate result of which will be that the influence and standing of the American Society of Civil Engineers, which are now conspicuous, will gradually wane and finally be lost in the controlling organization of which we will become a chapter.

If the charge just quoted were true, there is no question whatever that the proposition now before the members of the American Society of Civil Engineers would be and should be defeated. The society would not and should not sacrifice its independence of action nor give to any other organization authority over it in the conduct of its affairs.

There is not, however, the slightest foundation for the charge above made. Instead of its being true that the United Engineering Society has authority over the founder societies, the exact opposite is the case. The United Engineering Society is controlled by the founder societies. It is nothing more or less than a board of trustees appointed by and responsible to the several founder societies. It is the duty of this board of trustees to manage the building and its appurtenances in the interest of its owners. The offer of this board of trustees to the American Society of Civil Engineers was made by special authority from the governing boards of the founder societies. The board of trustees which constitutes the United Engineering Society is made up of representatives elected by the several societies, and these trustees change from time to time as their terms of office expire.

Properly speaking, the United Engineering Society is not a society at all, as that term is commonly used. It has no members, and is merely an incorporated board of trustees, elected by the national societies, whose property it holds and manages in trust.

How little ground there is for the foregoing charge may be seen by the fact that the three national societies of mechanical, mining, and electrical engineers have now been owning and occupying the Engineering Societies' Building for 12 years. The governing board of each of these societies has been carrying on its work in its own way all these years just as independently and as free from dictation from the United Engineering Society or any other outside source as has the Board of Direction of the American Society of Civil Engineers during the same time. Such a proposition as the control of any of these societies by the board of trustees called the United Engineering Society has never been heard of and would not be attempted under any circumstances, for no authority for such control exists.

The contrast between the foregoing charge and the truth is evident to everyone. It passes comprehension why any member of the American Society of Civil Engineers should make himself responsible for such a sweeping perversion of the facts as that previously quoted on a question of such importance and interest to the society. Such misstatement is all the more inexcusable, because the engineer who made it was a member of the committee of the Board of Direction which investigated the proposition for removal of the headquarters and joined with the other members of the committee in signing the letter sent to every member, commending the proposal to the membership.

Concerning this statement, there are only two suppositions: One is that the statement was sent abroad with the deliberate intention to deceive the membership as to the facts in the case. It is not believable that the engineer who has circulated this statement would be guilty of such an act. The other and only reasonable supposition is that the engineer who has issued this statement has done so through misinformation and misunder-

standing and failure to investigate the facts in the case. Under these circumstances it would seem that the only right and honorable action for the man responsible for this statement would be to acknowledge his error and attempt so far as possible to set right the members whom he may have misled.

There are in the circular letter from which the quotation is made a number of other statements that are almost equally misleading. Space permits at the present time reference to only one of them. We quote as follows:

> It is stated that there will be no material difference in the annual cost of operation [in the society's present house and in quarters in the Engineering Societies' Building]. This depends on the construction put upon the word "material." Expressed in actual figures, the writer finds the actual difference to be $2,511 in favor of our present home, based on an official figure.

How this computation was made does not appear. In view of what has been said already, the old maxim, "False in one, false in all," might be assumed to apply. For members of the society who wish to know the facts in the case, however, it may be of interest to compare a statement of the expenses incurred by the American Society of Civil Engineers in operating its present house at 57th St. with the expenses of the American Society of Mechanical Engineers in connection with its occupancy of the Engineering Societies' Building. The figures are taken in both cases from the official report of each society's governing board for the last year.

The report of the secretary of the American Society of Civil Engineers for the year ending Dec. 31, 1915, contains the following items that are chargeable to occupancy of the society's house: Caretaking, $1,861; house supplies, $136; maintenance of house, $3,033; heat, light and water, $1,304; total $6,334. The annual report of the Finance Committee of the American Society of Mechanical Engineers, rendered at the last annual meeting, shows an expense for the occupancy of the Engineering Societies' Building of $3,600.

It will be rightly judged by the members of the American Society of Civil Engineers, however, that differences of a few thousand dollars either way in the operating expenses of the society in connection with the proposed change are of trifling importance compared with anything affecting the welfare and prosperity of the society as a whole. The point on which greatest emphasis should be laid, we believe, is that in discussion of the pending question before the society the members are entitled to know the absolute facts in the case, free from all prejudice and preconceived ideas.

⁂

What Purpose Does a Code of Ethics Serve?

A committee of the Western Society of Engineers, made up of men eminent in the profession and of high character, has drafted a code of ethics which the society is to consider and adopt, if it approves. This code is entirely different from the codes that have been adopted by other engineering societies. Other codes consist for the most part of statements as to where an engineer's duty lies in certain specific situations that often recur in the profession. The code drafted by the Western Society of Engineers' committee, on the other hand, is an exposition of general principles that should govern any professional man in his conduct toward fellow-members of his profession, toward his clients and toward the public. It specifically avoids mention of specific cases and direction as to conduct therein.

No one, certainly, can criticize the lofty spirit that prevails in this code, nor can anyone question its value to the engineer who will seriously study it and accept its principles as a guide to conduct. The question is whether this is the sort of code of ethics that is the most useful for adoption by an engineering society. The answer to this question turns upon a clear understanding as to what purpose a code of ethics is to serve. To put the same problem in another way, Is it the purpose of a code of ethics to inspire those who join in its adoption to right living, high thinking and a high plane of moral conduct, or is it intended as a guide to correct conduct in specific cases where a man may honestly be puzzled as to where his duty lies?

Other engineering societies which have dealt with this problem have agreed that a code of ethics should be a set of statutes, as a definite guide as to what is correct conduct, with the incorporation in certain cases of some elementary moral principle such as the Golden Rule. It is true, as the Western Society committee points out, that no formulated code will cover all the ethical cases that may arise in the course of an engineer's professional practice. What such a code can do is to cover the cases which most frequently arise and on which opinions of engineers of inexperience are most apt to need guidance.

It is perfectly true that the majority of the members of a high-class engineering society, especially those of experience and standing, have little need of a code of ethics. They have learned by experience the proper rules of conduct in their professional relations, and they are no more likely to refer to a code of ethics as a guide to their behavior than they are to refer to the standard textbooks on elementary principles in engineering, which they studied when laying the foundation for their career.

The case is different, however, with the younger men who are gaining their experience. Even though they may be animated by such high principles as are set forth in the code proposed for the Western Society of Engineers, they are living in a practical world and not an ideal world; and they need to know what is accepted by the profession as sound ethical conduct when certain knotty questions arise. It is in the guidance of men of this class that the chief value of a code of ethics lies, and it is for this reason that a code made up of definite statutes seems to us more useful than a code that merely states general principles.

⁂

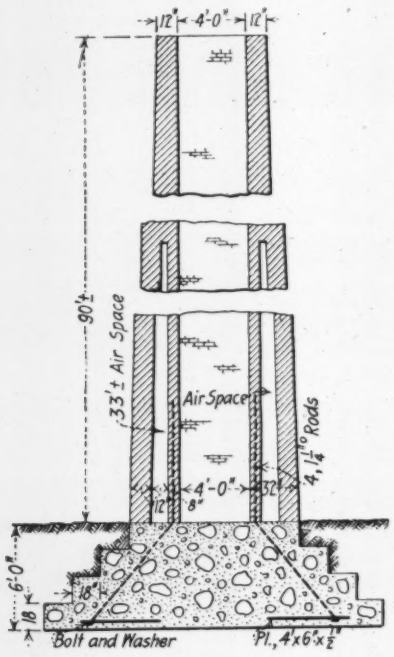
That accidents will happen to water-supply conduits of whatever material was shown in January of this year, when a slide due to wet weather wrecked a short section of the concrete supply main of Victoria, B. C. A reservoir below the break saved the city from having its water-supply cut off. This incident is significant in view of the agitation for a "concrete and steel" pipe line which occurred at Seattle after wood-stave pipe line No. 2 was put out of commission a few weeks ago. At Seattle lack of storage for some parts of the city resulted in cutting off the water-supply for three days. Even duplicate pipe lines were of no avail, because when one broke, the other one was out of commission for repairs. Plenty of storage below the break would have saved much anxiety and considerable expense.

Letters to the Editor

An Old Brick Chimney with a Cantilever Base

Sir—A recent conversation with an old mason and contractor may be of interest to the profession. The substance of it follows:

This mason in 1881 constructed a chimney at English Center, Lycoming County, Pennsylvania, for a tannery. The chimney had a base about 12 ft. square, founded 6 ft. below the surface of the ground, stepped up and in with 18-in. steps, and was of rubble masonry grouted with hydraulic mortar. The superstructure of the chimney was of brick, with walls 32 in. thick at the base,



OLD BRICK CHIMNEY WITH INTEGRAL CONCRETE BASE

tapering to 12 in. at the top—about 90 ft. above the ground. Embedded in these brick walls and foundation were sixteen 1¼-in. round rods, which extended from near the base of the foundation to about 33 ft. above the ground, four rods on each side, situated near the flue and flaring out in the base to correspond with its greater width, as shown in the sketch. These rods engaged iron plates 4 ft. long, 6 in. wide and about ½ in. thick, being secured by bolts and washers.

The reason for having the rods embedded as set forth was that some chimneys in that neighborhood had blown down in high winds. The rods were used to give greater stability, so that the chimney would be the more likely to retain its upright position against the overturning effect of a high wind, the stabilizing effect of the earth-fill being clearly recognized when the chimney was thus bound together in one mass.

The mason's reason for not using concrete was that crushed stone was relatively expensive, explosives and rock-crushing machinery not having reached their present development; and the Rosendale cement used at that time was $2.50 a barrel at the railroad, several miles away. It was not the difficulty of using forms that determined the use of brick, as he asserts that he constructed a reservoir 16 ft. in diameter and 12 ft. deep, the lining of which was concrete 1 ft. thick, with earth embankment on the outside. This concrete lining was placed in 1-ft. layers between circular forms of ½-in. white-pine sheathing, which were raised as the concrete was placed, and fastened for the further placing of concrete.

This certainly looks like an early use of the T-wall section. It is immaterial what is retained in a vertical position. This chimney was surely a retaining wall. It matters not if it were only 6 ft. long; the principle was there just as certainly as if it were 6,000 ft. long. It might be said that it was never loaded or brought into use; but in backfilling, it probably retained even earth in unbalanced heights, and the first wind was a trial or use of the principle.

B. A. Wise,
Bradford, Penn., Feb. 28, 1916. City Engineer.

Lime To Correct Acid Sludge in Imhoff Sewage Tanks

Sir—In your issue of Mar. 2, 1916, is an important letter by W. L. Stevenson, of Philadelphia, reciting experiences at the Pennypack Creek plant, whereby sludge decomposition in Imhoff tanks was benefited by the addition of lime.

I do not doubt the correctness of Dr. Imhoff's views of his experience in the Emscher district, as stated in his article in *Engineering News*, Jan. 13, 1916; but to advise in general against the addition of lime seems to me to be very questionable. It may be that iron or other products in the sewage of the Emscher district may make it unnecessary to add lime there.

Generally speaking, however, the use of lime in many cases may prove most helpful in bringing about proper bacterial conditions within a sludge-digestion chamber where, without such lime treatment, a needlessly long period might be required for establishing satisfactory septicization. This would be true especially in plants where stirring arrangements are deficient or absent for bringing about a mixture of sludge that occasionally after quite long intervals is found to be in an acid and undigested stage.

Different results no doubt follow the decomposition of sewage sludge of varying composition when acted upon by various types of bacteria. What the relative significance may be of different kinds of bacteria and of different ingredients in the sewage solids is a matter upon which we have not complete information. It has seemed to the writer that the predominating types of bacteria rather than the composition of the freshly deposited sludge are of most significance.

This tentative conclusion has been reached as a result of the observation at various Imhoff plants that different compartments, each receiving the same sewage, have during their earlier stages shown quite marked differences in behavior. I agree with Dr. Imhoff that it is necessary to provide proper bacteriological environment. It seems to me that stirring arrangements are highly important and that excessive acidity may arise, particularly in the case of Imhoff tanks receiving domestic sewage, wherein the use of lime for a time at least would prove most beneficial.

GEORGE W. FULLER.

New York City, Mar. 6, 1916.

Early History of the Bone Cantilever Wall

Sir—In your recent article on the Bone retaining-wall patent (Feb. 10, 1916) you make the commendable statement that *Engineering News* has thought it worth while to publish the history of the Bone patent, for the reason that the engineering profession is entitled to know the facts. It is very apparent, however, that a number of the points of history and facts were misrepresented and omitted. In justice to the infringing engineer and to the patentee it seems only proper that the full history of reinforced-concrete retaining walls be set forth from our point of view.

There was a great difference in the early work of Bone on reinforced concrete as applied to retaining walls and that of his contemporaries. Mr. Bone's efforts were exerted in the actual erection of life-sized reinforced walls. The contemporaries and alleged anticipators engaged themselves merely in discussions as to whether a successful device could be constructed and to the obtaining of impractical and "paper" patents. None of the alleged anticipations passed the "limits of mere suggestion of unsuccessful experiment." None of the contemporaries succeeded in devising a structure that anyone ventured to build on a large scale.

Before applying for a patent in 1898, Mr. Bone prepared plans and bid on reinforced-concrete retaining walls for a $20,000 job at Hamilton, Ohio. Although the new type of wall showed a marked saving, the bid was not accepted. From that time on, the inventor endeavored continuously to get plans adopted or bids accepted on his new type of wall. Although a saving in cost could be effected in each case, everyone was afraid of the wall because it looked so thin and seemed so novel. Calculations were presented to show stability. These were verified by numerous experiments with wood models and colored stratified sand to show the action of the retained material. Circulars were sent to the engineers of all important railroads of the United States, explaining the merits of the invention and soliciting opportunities to present designs. In 1899 to 1902, letters were written to a number of the leading consulting engineers of the country, asking for their opinions on the new invention. All complimented the novelty of the device, but for one reason or another were doubtful of its practical utility. These letters were not written for publication, but an excerpt from one may serve to show the view taken by the leading engineers of that time.

The dimensions of your wall and the stresses to which it is subjected, to meet any required case, are open to considerable doubt. As the theory of gravity walls involves too many assumptions to have any value, and as practice is the best guide, this will probably apply to your wall also. I would make several experiments for various heights and see if your theory fits them all.

About the time the patent was granted, an article describing the new wall was sent to *Engineering News*. The article was refused publication on the ground that, being merely a patent, it was of insufficient interest to engineers. The editor stated, however, that if a wall as actually built could be produced, its description might be of interest.

These early efforts show conclusively that, contrary to the claims made by some infringers of the present day, the invention was by no means self-evident to the designing engineer. The leading engineers of the country could not see that it was practical; and the editor of the leading civil-engineering paper could not see that this device, which has now saved the country millions of dollars, was even worthy of discussion. This is no discredit to the leading engineers nor to the well-informed editor. It merely shows the state of the art at that time. It shows that the best technical minds of the day could not see the virtue in a light concrete retaining wall reinforced with steel and that it took more than ordinary vision to foresee its utility.

It was after three full years of effort before the patentee could induce anyone to risk letting him erect the first wall. This wall was built at Black Lick, Ohio, in 1901. It is known as the first reinforced-concrete cantilever retaining wall built in the United States and the first in the world, with the exception of a wall built by J. Lehman in Denmark. Mr. Lehman's wall was of only a moderate height, except a small portion that had a maximum height of 9 ft. The Black Lick wall had a maximum height of 28 ft.

After erecting the first wall, which proved a success, the patentee was hopeful of securing further business. He advertised with renewed vigor on a larger scale, distributing thousands of circulars and pamphlets and offering to prepare plans and grant licenses for a compensation of one-quarter of the saving effected by its use as compared to gravity designs, calculated for equivalent stability. This offer has been standing ever since. Although this should seem very attractive, but little business was secured. The majority of engineers approached seemed loath to have their clients or employers think that any other design could be better or more economical than their own.

Descriptive matter, plans, methods of design, etc., were sent to various patent-bar manufacturers. Some of these manufacturers, with no reply at all, came out in their very next catalog issue with cuts and descriptions of the Bone wall, but with no mention of the inventor or a patent. Later and for many years since, they have advised their customers that the Bone patent was no good. This was in face of the fact that counsel advised them that the Bone patent had an excellent chance of being upheld in the courts. Even some textbooks have unwarrantedly precedented the courts by stating that the Bone patent was probably of little value. All of this was unfair to the infringing designer and to the patentee.

The work secured by the patentee was principally in southwestern Ohio and on small jobs. The accounts of these jobs were distributed throughout the country from time to time by circulars and pamphlets advertising for further business. Accounts of some of this work were

published in periodicals and read in several papers before the Ohio Engineering Society.

Then, after the patentee had promoted his wall for about six years and had demonstrated its efficiency and economy, other engineers began slowly to appreciate its worth. Many of these engineers decided that, with the data and examples put before them, they would make their own plans and avoid payment of royalty. When confronted with requests for royalty, the infringers usually tried to excuse themselves on the ground that the idea was old or that they had gained their idea elsewhere. But when their authorities were traced back, they almost invariably led to the publications originated by Bone himself. The patentee was unable to get compensation for any large jobs. The large infringers defiantly refused payment except by lawsuit. They knew well enough that the patentee was not financially able to fight them in the courts. Even when the patentee made designs and furnished plans by which the walls were built, he could not get compensation from the large infringers. The mere engineering service of preparing the plans for a specific job, however, was not so much of a loss as the years of work spent in convincing engineers of the practicability and advantages of the patented wall, the deriving of new formulas and data for use in design and the risks taken in erecting the first walls.

It became evident very early that, no matter what the engineering service, the patent would have to run the mill of the courts, as is the usual course of patents. The patentee then began to exert himself toward getting financial backing. After two years of endeavor in this line he succeeded in getting some Cincinnati capital to invest, and in 1906 the "Concrete Steel Retaining Wall Co." was incorporated. The object of the company, besides protecting its interests by necessary lawsuits, was to continue on a larger scale the work started by the patentee, both as to designing and contracting for walls. Soon after the company had been launched and a catalog issued and distributed, the moneyed interests withdrew, but business was continued under the same name. The patentee endeavored for six years more to interest capital. Several reorganizations were instigated, but the project finally failed. The discouragements encountered in these attempts at promotion are the same story as the early history of nearly all valuable inventions. The universal arrangement is a scheme of the capitalists in which the inventor is eventually to be squeezed out and all of the fruits to fall to the capitalists.

About 1907, soon after the organization of the Concrete Steel Retaining Wall Co., the company, to advertise itself, did much work toward education in the design of reinforced walls. Education was badly needed. Little, if anything, was to be found in textbooks. Designs were still being made by the old middle-third rule. Little attention was given the economic proportioning of heel and toe. Designs were not adapted to their particular foundations nor were eccentric settlements looked into. In short, designers were following the methods used for gravity walls, which obtained but a part of the advantages of the reinforced walls. The patentee and his associates had devised new theories and formulas adapted to the reinforced wall. These were set forth in catalogs and also, with curves and charts to facilitate their application, were published in periodicals. They have been circulated to anyone interested ever since.

Much of the patentee's time was taken up in attempts to interest capital, but he also individually took contracts for walls in addition to making designs. About 1908 an arrangement was made with the Ferro Concrete Construction Co., Cincinnati, a large contract company, to present bids on retaining walls under license of the patent. This company solicited work from all important railroads in the country, but failed to secure a single job.

In 1912 the patentee received from a contract, for the first time, sufficient profit to warrant bringing a lawsuit and defending his business. The first suit was brought, not against a small infringer, but against a large corporation. It was against the Chicago, Burlington & Quincy Railroad Co., which sent men to Europe to find anticipations. They returned empty handed. The results of this case furnished the first working basis to continue prosecutions against infringers. There have since been a number of suits brought, mostly against large corporations. Most of the cases have been settled out of court. The reason was not because the defendants were unable to stand lawsuits. They were much better able than the patentee. There have been three decisions in favor of the patent and one dismissal. The opinion of Judge Anderson, while frankly against the patent, does not go so far as to hold any of the claims invalid.

The question of anticipation is, from necessity, to be settled only by the courts, and we shall not discuss that; but if the engineer who desires knowledge of the facts will look up and compare the originals of the alleged anticipations as published in *Engineering News*, Feb. 10, 1916, p. 254, some of them will appear in a different light.

When engineers once appreciated the economy and advantages of reinforced-concrete cantilever walls, they could at any time have obtained a license to use the patent. The business methods have always been clearly given in the catalogs issued, and there is no excuse for not taking advantage of the patent license. The catalogs were widely and carefully circulated. It is true that extensive magazine advertisements were not used, and infringements were not at first prosecuted, for the simple reason that the patentee did not have the money to do so. The patentee, not from choice, is now forced to hunt up infringers and make claims to obtain recompense for what he has done and for what he knows he is justly entitled to.

It has been argued that an engineer should devote his invention to the public. The author of such a statement shows his absolute ignorance of what work it takes to bring an ordinary invention into use. When something actually novel is originated, the public does not receive it with open arms. Its merits must be shown and proved. The service rendered in giving the world an invention consists by no means of the mere conception of a thought. Aside from the work of experimenting, it usually costs years of work before the invention is driven into public favor and appreciation. The man who lets his idea drop would do little good compared with the man who works with that idea until some good use is made of it. It would be very gracious for a man to devote years of his labor *gratis*, but an inventor has no more occasion to do it than the ordinary engineer would have to perform his daily work for nothing.

It is a satisfaction to know that the prejudice against patents, among engineers, is by no means unanimous.

There are many fair-minded men of the profession who want to see anyone who has rendered a service paid for it. Whatever the criticisms against the Patent Office system and judiciary methods may be, the case of the Bone patent is one in which the primary object of the patent law is, partly at least, attained. It is, although after many years, giving the inventor a reward for his labor.

EVAN P. BONE,
Frank A. Bone & Son.

Cincinnati, Ohio, Mar. 11, 1916.

[*Engineering News* is glad to give space to this very frank statement. There is no doubt that Frank A. Bone in the beginning believed himself to be the original inventor of the reinforced-concrete cantilever wall and honestly tried to promote its use. His experiences only emphasize the conservatism of the engineering profession and the reluctance of the American engineer for many years to accept and believe in the merits of reinforced concrete. But because most American engineers of 15 years ago were unable to recognize the advantages of a construction already adopted in Europe and described in the European press is no reason why American engineers of today should be made to pay tribute to one who did.

While agreeing with Mr. Evan Bone that the legal aspects of the controversy cannot be successfully discussed in these pages, *Engineering News* must, in answer to some of Mr. Bone's statements, give as its opinion that:

1. A number of the "alleged anticipations" by European engineers did go beyond the "limits of mere suggestion of unsuccessful experiment."

2. Reinforced-concrete cantilever walls were built in Europe before 1901.

3. The Chicago, Burlington & Quincy R.R. did not have to send men to Europe to find anticipations. Records of such anticipations were available in the nearest good-sized library. Furthermore, the railroad's attorneys evidently did not discover the more important anticipations mentioned in *Engineering News* of Feb. 10, 1916.—Editor.]

Will Prosperity Last?

Sir—In *Engineering News* of Jan. 6 the department of Construction News shows what, at first sight, seems to be a very optimistic beginning for the year 1916. In your discussion of the business outlook you pass along the good word one hears on all sides:

> **The spirit of optimism and hopefulness prevails to a degree that has not been apparent for years, and the general belief and expectation is that there will be such prosperity during the year as will recompense the people of this country for all their past misfortunes. . . . Prices on all lines of building material have advanced, with further expected increases when the season opens up in the spring. This is due a great deal to the high price and scarcity of labor.**

In view of this high price of materials, this scarcity of labor and increased cost of delivery it seems that there should be a note of pessimism rather than the opposite.

There is no topic of greater interest to engineers than that of future business prospects and general construction, for in boom times there is a large amount of construction work, necessitating a great deal of technical labor, while in dull times, or financial depressions, the opposite is true. The one means increase of salaries, continuous employment and prosperity, while the other means a nonpaying business or bankruptcy, reduction of salaries or perhaps the very unsatisfactory state of loafing altogether.

The industries of the country have passed from comparative stagnation to tremendous business in less than a year. Our principal industrial product, steel, is being manufactured at a greater rate than ever before. The prices have increased from 50% to 300% in most finished products. Within a few days many inquiries for steel products have been withdrawn because of the high prices. This condition contains the germ of financial depression, for it indicates that the holders of the purse strings will not extend construction work more than is absolutely necessary for maintenance purposes, when prices are at the present level.

Our financial history furnishes instances where conditions were practically the same as at the present time. In 1862 a boom started in which the demand for iron products increased 100% within a few months. It being impossible to supply such a demand, prices rapidly increased. The war, which first depressed business, helped to increase it in 1863 and 1864. The boom reached its height in 1864, when many factories were obliged to close their doors for want of construction material. Investment in new construction almost entirely ceased, but construction for war purposes continued. The price of iron increased from $35 in 1863 to $80 in 1864. At this high point construction material began to accumulate rapidly on all sides, and the price of iron fell 50% in ten months.

People here attributed this remarkable occurrence to the Civil War; but there was no war in Europe in which England, France or Belgium was engaged, yet each of these countries suffered severely from an industrial depression that lasted for several years.

There is a marked similarity between the position of the United States at the present time and that of England and France in 1866 and 1867. Both the Union and the Confederate states purchased at exorbitant rates all the munitions that could be had, causing the price of all construction materials to rise beyond the point where the public would invest in new construction. This situation involved at once a falling off in the employment of labor and a resulting financial depression.

At the present time the influx of gold to pay for munitions—bought at tremendous prices—thereby leaving a large unearned increment in the hands of the favored few, will but temporarily aid in creating prosperity for business as a whole.

The present boom has put construction material nearly up to the price level of 1907, and this has been done within a year, whereas in 1907 three years of expanding business were realized before the crash came. This world war has then produced an economic condition, so far as prices of material and labor are concerned, which would have required from two to five years with ordinary business revivals such as have taken place during the last fifty years. We are, therefore, nearly at the brink of depression and consequent stagnation of all investment in new construction, because of constantly increasing prices largely produced by external causes.

G. L. BILDERBECK.

New London, Conn., Jan. 30, 1916.

Test Data on Loss of Head in fire hydrants of different makes with water flowing through at high rates is desired by Water-Works Superintendent. References to published data or brief summaries of unpublished information would be welcome.

Keeping Open a Mexican Railway

EDITORIAL CORRESPONDENCE

No better example of the tenacity of American engineers could be found than the keeping open of the Southern Pacific Ry. of Mexico during the last five years. During all the troubles of that unfortunate country this railway has never been out of operation for over two weeks at a time. It is operating today (Mar. 9) all sections of the Southern Pacific and the Sonora Ry. except a 120-mi. section running from Rosario to Tepic. One group of revolutionists and brigands after another has burned bridges and caused destruction until, as Vice-President and Chief Engineer L. H. Long told the editor, what is left is a "pretty bum road," so rough and rugged that on a recent trip he jokingly remarked that from the front platform of his car one could always see the locomotive either over or around the other cars. Nevertheless, the railway is passable for both freight and passengers.

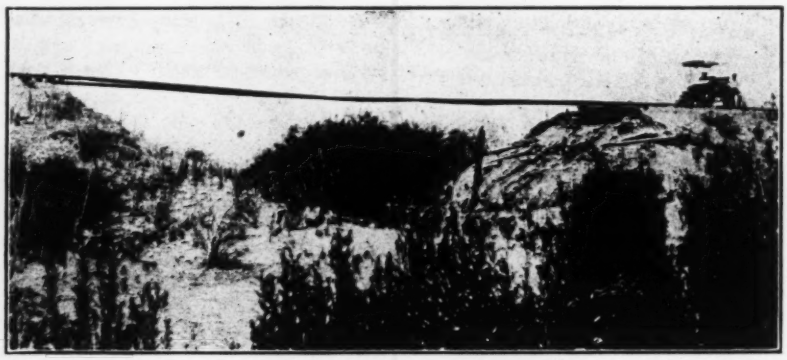


FIG. 1. BRIDGE ON SOUTHERN PACIFIC OF MEXICO BURNED BY VILLISTAS IN JUNE, 1915

A few of the larger bridges, like that shown in Fig. 2—the Yaqui River bridge—have not been destroyed, doubtless because it would have required too much energy. But every structure that would burn has been burned, and this included in some instances the substructures of steel bridges. The great majority of the bridges destroyed have been timber trestles, varying in length from 15 to 1,575 ft. The aggregate length of bridges destroyed between December, 1910, and Mar. 1, 1916, has been 75,151 lin.ft., including 71 openings. Of this, 5,945 ft. was work that has been destroyed more than once.

Fortunately, all the streams crossed are dry in all except the rainy season, so that to keep the railway in operation, instead of attempting to rebuild the ruined structures, as was done at first, the plan is now to detour around the old crossings and dip down into the river bottoms with as little grading and bridging as possible. The part of the roadbed carried away by floods is cheaper to replace than that destroyed by brigands.

In their experience with the numerous *de facto* governments of Mexico the Southern Pacific Co. officials have preserved a strictly neutral attitude, recognizing whatever individual or group of individuals happened to be in power, although this frequently meant that different parts of the line were under different jurisdictions. There has been but little interference with the actual operation of the railway, and but very few employees have been killed except in actual battle, when they had enlisted under one of the current commanders.

The various marauding bands have become very expert in the destruction of property, particularly of railway property, and have learned most of the tricks of the better-trained, though hardly more experienced, troops of the past. One of their pet performances, in fact, was well known in the Civil War. This is the total annihilation of the railway track, not only by tearing up rails and ties, but by using the ties as material for a bonfire in which the rails are heated red hot and when in that condition twisted around nearby telegraph poles or trees. The restoring of a line so destroyed is a man-sized job.

Apparently, however, there has been little of the dynamiting of the larger more solid structures such as has been so common in the present European War, and the results of which have so often been pictured.

FIG. 2. YAQUI RIVER BRIDGE OF THE SOUTHERN PACIFIC OF MEXICO

One of the few large structures which have not been destroyed

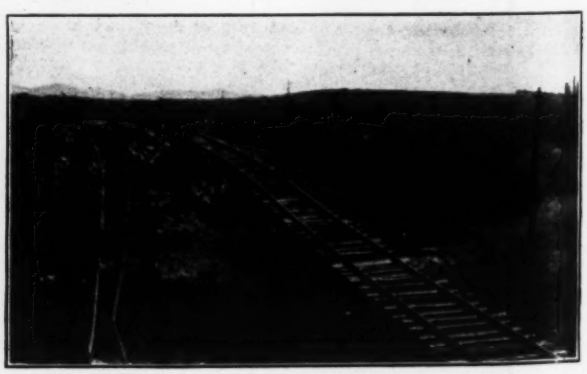


FIG. 3. DETOUR THROUGH RIVER BOTTOM AROUND BURNED BRIDGE

Dry stream beds are used instead of rebuilding bridges

Detroit Sewer Wrecked by Gasoline Explosion

On Sunday, Mar. 12, 1916, at about 9 p.m. the Scotten Ave. sewer in Detroit was wrecked by an explosion of gasoline vapor, and the pavement overhead was ripped up for a length of over 2 mi. The detonation was severe and was plainly heard for 15 mi. Residents of Scotten Ave. were thrown off their feet, and several were shaken out of bed, but only three persons were injured. The street was paved with brick on a concrete foundation, and at places slabs were thrown up, as shown in the accompanying illustration. At two places the city water mains were broken, and nearby cellars were flooded. A dock near the outlet of the Scotten Ave. sewer was set on fire by burning gas. The damage to the city has been roughly estimated by Commissioner of Public Works George H. Fenkell at $500,000. The Scotten Ave. sewer was built in the years from 1888 to 1908 at a total cost of $93,800. The explosion was caused by the escape of some 10,000 gal. of gasoline from a tank-car on a private siding of the Raths Oil Co. Had it not been for the facts that most of the sewers in Detroit are located in streets extending at right angles to the river and that there are some fifty odd outlets into the Detroit River, the distribution of the gasoline vapor would have been wider and the damage from explosions would have been much greater.

The tank-car that caused the trouble was the property of the German-American Car Co., Farrell, Penn. It was built in 1913 and was leased to the Wabash Refining Co., Robinson, Ill. The tank was stenciled to show that it had been tested to 60-lb. pressure and that the safety valve had been tested to 12 lb., but the dates of inspection were not stenciled. The leakage was through the outlet valve located under the center of the tank bottom. This had been capped, but the cap was fractured by freezing of trapped water. The leakage was at a rate about one-fifth of full discharge.

The valve was removed after the tank was freed of gas, and it was found that a 5/8-in. bolt had been embedded in the lead seat of the nozzle, so that the valve could not completely close.

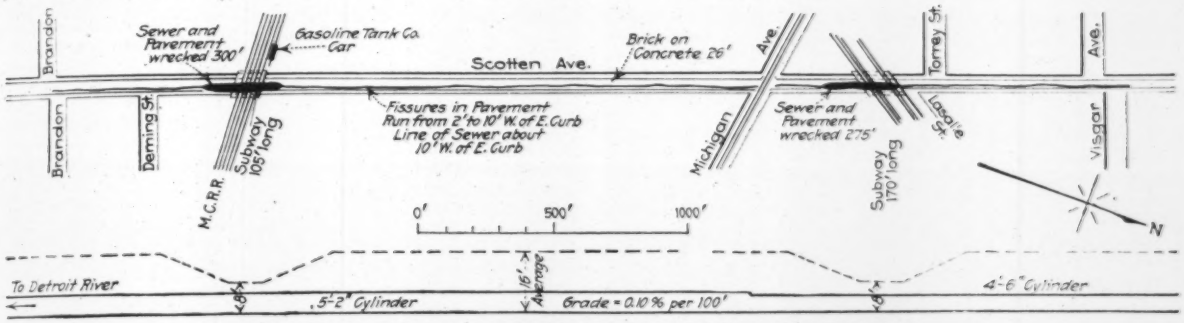


FIG. 1. SKETCH MAP AND PROFILE, SCOTTEN AVE., DETROIT

FIG. 2. RESULTS OF SEWER EXPLOSION AT SOUTHERLY CROSSING UNDER MICHIGAN CENTRAL R.R.

FIG. 3. PAVEMENT UPHEAVAL NEAR LA SALLE ST.

News of the Engineering World

Rapid-Transit Railway System for Cincinnati

Plans for the new rapid-transit railway system in Cincinnati were advanced another stage on Mar. 14, when the City Council passed an ordinance submitting to popular vote on Apr. 25 the ordinance for the issue of $6,000,000 bonds to build the proposed system. Preliminary surveys for the rapid-transit system were made by F. C. Edwards and Ward Baldwin in 1914. Their surveys included a belt line around the city, with a loop in the business district. About 6½ mi. would be built as a subway.

National Septic Process Protective League

The National Septic Process Protective League was formed at Des Moines, Iowa, on Mar. 14, 1916. About 35 delegates were present, from Iowa, Kansas, Minnesota and Ohio. Dr. H. M. Bracken, Minneapolis, secretary of the Minnesota State Board of Health, was elected president, and F. G. Pierce, Marshalltown, Iowa, secretary-treasurer. The object of the league is to defend all suits filed against its members for the infringement of Cameron septic-tank patents. All municipalities, corporations, companies and individuals interested in sewage disposal are eligible to membership, subject to the approval of the executive committee, upon the payment of the proper fee.

Prof. A. Marston, Ames, Iowa, discussed the development of septic tanks and the litigation in regard to the claim of the Cameron Co. for royalties. R. E. Sampson, assistant attorney general of Iowa, explained the legal status of the Cameron claims, especially in the light of the recent decision against the City of Winchester, Ky.

Following a general discussion, a committee was appointed to report upon a plan of organization. The committee brought in the following resolution, which was adopted:

Whereas, The Cameron Septic Tank Co., of Chicago, is making demands upon municipalities throughout the United States for the payment of excessive royalties, on account of a certain alleged patent which it claims to own; and,

Whereas, This conference has been advised by able attorneys that in their judgment the alleged patent of the Cameron Septic Tank Co. has already expired and that it is no longer a live and valid patent upon which royalties can legally be collected; and,

Whereas, It is the judgment of those from the several states represented in this conference that the interests of the taxpayers and general public can best be protected by contesting the validity of said alleged patent, by ascertaining the scope of its valid claims, if any there be, and by refusing to pay any and all royalties to the said Cameron Septic Tank Co., on account of said patent, until after the courts of final jurisdiction have upheld the validity of such patent and the liability for such royalties; and

Whereas, The expense of defending suits of this character would prove burdensome to a single municipality; and,

Whereas, The benefits which would accrue from such a suit, if successfully contested, would prove of value to all of the municipalities from which royalties are being demanded and particularly to the taxpayers of such municipalities; now, therefore, be it

Resolved, That the National Septic Process Protective League be, and the same is, hereby formed for the purpose of aiding in the defense of any suit brought by the Cameron Septic Tank Co. against any municipality, company, corporation, state institution or private individual which is a member of this league, when such suit involves the validity of said patent.

The membership fees for cities are graded by thousands of population, as follows: Under two, $10; two to five, $15; five to ten, $20; ten to twenty, $25; twenty to fifty, $30; over fifty, $35.

There will be two directors for each state. Those so far chosen are: Iowa, Dr. J. F. Cole, president Iowa League of Municipalities; Lafayette Higgins, engineer State Board of Health, Des Moines. Kansas, C. A. Haskins, engineer State Board of Health, Lawrence. Ohio, W. H. Dittoe, engineer State Board of Health, Columbus. Illinois, Langdon Pearse, assistant engineer Sanitary District of Chicago; Paul Hansen, engineer State Board of Health, Urbana. California, W. J. Locke, secretary League California Municipalities; Charles G. Hyde, consulting engineer State Board of Health, Berkeley. Minnesota, H. A. Whittaker, assistant engineer State Board of Health, Minneapolis; G. A. Gsell.

It is interesting to observe, as brought out in the discussion, that the alleged infringements of the Cameron septic-tank patents are not confined to what are frankly called "septic tanks," but extend "to those which employ putrefactive reduction of sewage solids, but which for purposes of evasion have been styled 'sedimentation' or 'settling tanks,' as well as to the more recently exploited 'Imhoff' or 'two-story' septic tank."

It is further important to notice that the terms for licenses are 3% per annum on the original cost of the complete plant and subsequent additions, "including" (to quote from a letter signed by Mr. Wyllie, of the Cameron Septic Tank Co.) "the tanks, contact beds, filters or other appurtenances, for the number of years each plant has been in operation to date of settlement, plus an additional 3% for the remaining unexpired term of the patent."

Water-Supply and Sanitation Are Big Military Problems

To secure a safe and adequate water-supply and safely to dispose of all wastes are the greatest problems of military camp making is what was told the audience at the sixth of the New York City engineers' military lectures, Mar. 20. Tactical considerations fix the location of camps for an army in action, but otherwise engineering considerations prevail—good water, dry ground, presence of wood, grass and forage, location of roads and railroad facilities. The best ground has a tough turf over a porous subsoil. An old camp ground should not be reoccupied for two or three months.

The army field regulations provide standard camp plans—which usually cannot be followed except as to preserving organization units, widely separating kitchens

from latrines and pickets, etc. The engineer troops are sent ahead to lay out the camp and are accompanied by representatives of each organization to guide the forces to designated places. One battalion of engineers is allotted to an army division, but it is given other troops for labor. Where the camp is by a stream, the various water-supplies are taken out in the following order from upstream down: Drinking and cooking, watering horses, bathing, laundry. Guards are immediately posted to secure observance of these limits.

When the main body arrives, the first work is to set up the kitchens; then the latrines are built. The third work is getting in water and wood, and finally main tents are pitched.

In most cases it is necessary to purify the water-supplies—by heat, filtering or chemical action. The Forbes regenerative sterilizer has been adopted in America in small and large units, producing 15 and 300 gal. per hr. and using 1 and 20 qt. of oil fuel per hour. The Darnell mechanical filter, devised by the Army Medical Corps, is highly regarded. It requires a tank, two cans, a siphon filter and cloth; alum and sodium carbonate are used as the precipitant. Only 5 min. is required to set up, and 2 or 3 to start operation; 98% bacterial reduction is secured plus good clarification.

In disposing of wastes sewers are usually impracticable. Garbage is always burned—preferably in a stone-lined incinerating pit. For fecal matter simple pit latrines are most used and gradually filled in with the excavated dirt. The McCall portable incinerator, however, is widely used; with this the wastes are received in pans over the firebox (cold except when cremating).

Frozen Concrete and Poor Design Cause Failure

A reinforced-concrete roof that was being placed in the remodeling of the old Memphis Brewing Co.'s building for a storage warehouse for the Paterson Transfer Co. at Memphis, Tenn., collapsed on Mar. 6 and injured two men who were caught under the débris. The roof was designed by the architect in charge of the remodeling of the building. It covered an area of 26 ft. 4 in. by 67 ft., with beams spanning the short side on 12-ft. centers.

The slab was 4 in. thick, with $\frac{5}{8}$-in. round rods on 12-in. centers, and the beams were 7 in. wide by 8 in. deep under the slab, with four 1-in. square twisted bars all in the same horizontal plane. Two were bent up at each end 5 ft. from the support, at about 30°, and then ran horizontal to the support; the other two were straight for the full length. There was a 1-in. square twisted bar about the under side of the slab for a length of 20 or 22 ft. through the center. This apparently was to tie the stirrups over. These stirrups were $\frac{1}{4}$-in. rounds spaced on 12-in. centers.

The concrete was poured Feb. 6, and the forms were stripped on Mar. 6. The roof collapsed just after the forms were taken out. The highest temperature for February was 71° on the seventeenth, and the lowest after the roof was poured was 25° on the fourteenth, the mean for the first week being 46°. The low on Feb. 6 was 36°; on Feb. 7 it was 30°, and Feb. 8 it was 29°, the mean for all of February being 42.5°. The concrete after the failure was very crumbly and could easily be broken with the hand. With such shallow beams underreinforced and with concrete that did not properly set up, there seems to be no problem as to why the roof collapsed.

The roof had a pitch of 8 in. toward the north. In falling, it pushed out the south brick wall, which fell into the street, and the whole roof moved about 18 in. to the south and fell in badly shattered condition on the old floor beneath, which held under the impact.

The work was in the way of repairs and minor alterations and was apparently being carried on without permit from the building commissioner. A local engineer is now engaged in revising the design for better construction. It is the first reinforced-concrete failure that Memphis has had.

Code of Ethics for Western Society of Engineers

A committee of the Western Society of Engineers has recently presented a draft of a proposed code of ethics for adoption by the society. The committee was made up of Hiero B. Herr, chairman, John W. Alvord, C. R. Bart, P. Junkersfeld and C. F. Loweth. The code which the committee has drafted differs materially from the codes adopted by other engineering societies in that it consists of a statement of general principles instead of a statement of definite acts which are enjoined or forbidden.

The committee has studied the codes of ethics which have been adopted by other engineering societies, and its chairman prepared a compilation embodying the principal points of all these codes. After examination of this compilation the committee decided that "the general ethical principles and ideas as to the relations and conduct of the engineer cannot be effectively incorporated in a set of fixed rules universally applicable. . . . The best guide to correct detailed professional relations would be a keen appreciation of the general professional status and a conscientious attempt to be guided in each specific case by the spirit of the ideas set forth." Based on these ideas, the committee has formulated a brief statement of the basic principles underlying all professional ethics, which it believes sufficient for the needs of the society and recommends for adoption. The first part of the proposed code deals with the position and duties of professional men in general. It lays stress on the fact that the member of a profession uses knowledge for which he is indebted in great degree to the profession as a whole. The code then presents suggestions as to the duties which the engineer, as a professional man, owes by virtue of what he has received, as follows:

A. He can lead an honorable and upright life.

B. He can regard the profession as a fraternity and act on this theory.

C. He can lose no opportunity to improve his professional information to the end of bettering his service to his employer or his client.

D. He can uphold the dignity of his profession by cheerfully giving credit to his contemporaries for their good work and avoiding all envy or petty jealousy.

E. He can do his share in supporting societies created for professional benefit and contributing when possible to their store of useful knowledge.

F. When confronted with the necessity of honorable competition with professional brethren, it should be entered into with the utmost courtesy and consideration for all concerned and, to say the least, without public exhibition of greed, self-laudation, jealousy or ill-humor. Some degree of honorable and courteous competition among professional men is often inevitable, particularly for salaried positions, and at times

in all except the higher class of consulting work. This being so, the courtesies and ethics of competition should be studied and cultivated with especial care to the end that the fraternal feeling in the profession does not suffer. Competition in professional work, where it enters in at all, should always be on the basis of efficiency in service offered and never, knowingly, in price concessions.

G. The engineer should always assure himself, as far as possible, that the professional services he renders are in value reasonably in excess of the salary received or fee charged. Where he is in position to fix his own fee, the utmost conscientiousness about charges is to be observed.

H. He can be a "gentleman" always and everywhere. He can follow the "Golden Rule."

The code then takes up the specific duties of the engineering profession and, after explaining the responsibility which lies upon the engineer as a professional man, enumerates some of the responsibilities and duties of the engineer toward the public, as follows:

A. In all engineering problems the public safety ranks first and is above all other considerations.

B. In the development of the art of engineering it is incumbent upon the engineer to educate the public up to a right perception and appreciation of engineering problems.

C. The engineer should always stand ready to voice publicly, safety and security and sound economics in the public administration of engineering.

D. Service to the public, directly or indirectly, is the appropriate and natural opportunity of the engineer, and that it is even less well paid than private service is perhaps in part due to the fact that the engineering profession is indebted to the public primarily. Public service is therefore a peculiarly honorable service and should be especially respected.

E. General engineering advice may in certain emergencies and with reason and caution be appropriately tendered to the public without charge, but not to the prejudice of careful investigations where necessary, or to the discouragement of inquiry requiring ample funds, or to the cheapening or discrediting of the public problem in hand.

The final paragraph of the code sums up its principles and precepts as follows:

The ethical standards of the engineering profession should be those of a fraternity. The engineer should recognize that he is endowed by the profession and the state with specialized knowledge for peculiar, judicial and responsible public service involving the life, safety, comfort and convenience of his own and coming generations, and that in response to these he should so conduct himself as to be appreciative of his indebtedness to his profession for his opportunity and make return by every effort by a life of special usefulness devoid of unseemly greed and filled, if possible, with a multitude of those small courtesies the practice of which encourages the spirit of forbearance and is helpfully conducive to the fine art of living well together.

Another Thacher Patent Suit

A suit for infringement of United States Patent 617,615, issued to Edwin Thacher on Jan. 10, 1899, "for new and useful improvements in concrete arches," against the Transit Construction Co., New York City, was decided against the plaintiff by Judge Thomas in the United States District Court for the Southern District of New York on Jan. 8, 1916. The bridge in question is the Ashokan bridge of the Board of Water-Supply at Olive, N. Y. The case was decided upon the distinction between dependence and independence of the intrados and extrados reinforcing rods in the bridge.

The first main claim of the Thacher patent is as follows:

The combination with abutments and a concrete arch spanning the intervening space or a series of metal bars in pairs, one bar of each pair above the other near the intrados and extrados of the arch and extending well into the abutment, each bar of a pair being independent of the other substantially as described.

It was brought out in the trial that the original Thacher claims were repeatedly rejected by the Patent Office examiner, and Patent No. 545,301, issued to one Milliken on Aug. 27, 1895, was cited as a reference. The Milliken patent relates more to building construction than to bridges, but appears to contain all the elements of the Thacher patent—namely, abutments, an arch, a series of metal bars in pairs, upper and lower bars and bars extending well into the abutment. In the Milliken patent, however, the upper and lower bars are connected by means of metalwork. Following the Patent Office's rejection of the Thacher claim, Mr. Thacher finally submitted his claims with the added phrase, "each bar of the pair being independent of the other."

In the Ashokan bridge the upper and lower longitudinal reinforcing bars not only are connected by the usual stirrups, but they were firmly fastened by bolts and clamps to a number of transverse frames made up of structural shapes. The judge ruled that the connection between the crossframes and the arch bars is direct:

The arch bars are directly bolted to the angle-iron crossframes by heavy bolts at the bottom and top, and these bolts are drawn up very tightly so that the upper bars cannot move perceptibly without producing a corresponding movement in the lower bar, the connection between each upper arch bar and its corresponding lower bar being effected by several iron fastenings called stirrups. . . . The result of this arrangement is that each upper bar is firmly connected to the corresponding lower arch bar by angle-iron frames at several different points and by stirrups at ten more points.

The judge further states that this distinction between dependent and independent must be regarded as material in determining the question of infringement. He therefore ruled that the bill of complaint be dismissed. The judge further states that due consideration in reaching this result has been given to the opinion of Judge Rose in Thacher vs. Mayor, etc., of Baltimore, 219, Fed., 909, in which the claims in controversy were sustained. The question here involved was not before the court in that suit, as appears from the opinion. The question there involved was mainly of patentability, and it was held that the patentee had done something which his predecessors in the art had not and that the difference between the patent and the charged infringement (which did not involve in any way the dependence or independence of the bars upon each other) was substantially the same as that of the patent in suit.

Panama Canal To Be Reopened

Col. Chester Harding, Acting Governor of the Panama Canal, made the following announcement on Mar. 15: "Conditions in Gaillard Cut justify prediction that canal will be available for ships of 30-ft. draft on April 15, subject to probable temporary delays thereafter to meet exigencies of dredging fleet in completing canal to full width and depth and in removing shoals that may possibly develop."

A Break in the Concrete Water-Supply Conduit that brings Sooke Lake water to Victoria, B. C. (see "Engineering News," Nov. 18, 1915, p. 994), occurred on Jan. 22, 1916. An earth slide, due to wet weather, took place at the top of a steep embankment; and 12 lengths, or 48 ft., of pipe were carried about halfway down the slope, where they lodged. Six lengths were broken. As the pipe line was not readily accessible, temporary repairs were effected by cutting timber in the vicinity and utilizing boards from an old camp for a timber flume. Repairs were completed in about three days. As soon as the weather permits, C. H. Rust, city engineer and water com-

missioner of Victoria, writes under recent date a concrete trestle will be built and enough pipe will be molded on the spot to repair the break permanently. The only previous break on this pipe line occurred last fall, when owing to a forest fire, a large pine tree fell across the conduit, breaking one length of pipe and cracking three more. There was no water shortage during the time the water was shut off in January, as the rainy weather afforded an ample supply from the Humpback Reservoir, with a capacity of 150,000,000 U. S. gal., besides which the city last year tapped two large creeks on the line of the conduit.

A Small Car Fell from the 12th St. shaft of the Mill Creek sewer, St. Louis, on Mar. 16, killing one man at the bottom of the shaft. Just previous to the accident the car was being loaded with bricks on the street surface at 12th St., when it broke loose, ran downgrade and tumbled into the shaft. The men working at the bottom heard warnings, but two of them were struck by the falling bricks. The accident apparently was due to blocking the car improperly.

The Building Code of St. Paul, Minn., is being revised by P. E. Stevens, Consulting Engineer of St. Paul. Mr. Stevens' work will be reviewed by a committee made up of members of the Civil Engineers Society of St. Paul, the Architects Club and the Builders Exchange.

A Fire-Retarding Zone in Nashville, Tenn., is included in the revised building code which, according to local reports, is practically certain to be adopted by the Board of Commissioners. The zone covers a large area in which all buildings of a height of four stories or less shall be of either fireproof or mill construction. Buildings of a greater height shall be fireproof. The credit for this provision is due the Nashville Section of the Engineering Association of the South. The association sought to have all the buildings in this zone made fireproof, but owing to the opposition of real-estate men, architects and carpenter-contractors, this was prevented.

Plans for a New Terminal of the Pennsylvania R.R. in Pittsburgh are reported to have been approved by the engineering department. An expenditure of $5,000,000 is contemplated; it is expected that the directors of the road will in a few weeks order the work to proceed. A big porte-cochère on the present station will give way to a 12-story office-building addition. The steel will be designed for 22 stories. The passenger-service rooms will be lowered 15 ft., and two train levels will be used—suburban below and through-line above. Electric traction will be required for the lower level; and until the electrification of the suburban lines is undertaken, the lower level will not be used for trains.

The Committee on Safety Standards of the Pennsylvania Industrial Board held a public hearing in the North American Building, Philadelphia, Mar. 16, to consider portions of the code that will govern installation of elevators in Pennsylvania, excepting cities of the first and second class. The committee that approves safety devices met in Harrisburg, Mar. 21, to consider 30 different mechanical appliances submitted as safety devices. No safety device may be used in Pennsylvania unless approved by this committee, which includes James C. Cronin (chairman), Otto T. Mallery, Lew R. Palmer, Richard M. Pennock, Dr. Francis D. Patterson, John S. Spicer, Oscar E. Thompson and William Lauder, secretary.

The One-Hundredth Anniversary of the organization of the United States Coast and Geodetic Survey will be commemorated by a banquet at 8 p.m. on Apr. 6, at the New Willard Hotel in Washington, D. C. The speakers will be the President of the United States, the Minister from Switzerland, the Secretary of the Navy, the Secretary of Commerce and Dr. Thomas Corwin Mendenhall. On this day and the preceding, centennial exercises will be held at the new National auditorium. In three sessions 14 addresses will be made. An exhibit will be held at the New National Museum, consisting of surveying instruments and appliances, pictures of surveying operations and equipment; charts and other publications of the bureau.

Extensive Municipal Improvements at Harrisburg, Penn., having been completed, the Board of Public Works, which carried out the improvements, resigned on Mar. 14. From the proceeds of a loan authorized in 1902 a water-filtration plant was built at a cost of about $325,000; a sewerage system was improved at a cost of $365,000, and a dam across the Susquehanna River was built at an expenditure of $83,000. A 1905 loan of $367,000 paid for the Mulberry St. bridge across railway tracks and Mish Run and 18th St. and met the cost of further sewer construction. A loan of $334,000 in 1910 enabled the board to construct the Paxton Creek open sewer and an intercepting sewer along the bank of the Susquehanna River and also river-bank protection, at a total cost of $334,000. The board consisted of Edwin C. Thompson, D. E. Tracy and J. W. Bowman. It served without compensation.

The Sewage-Disposal Problem of Montclair, N. J., has been referred by the Town Council to fifteen resident engineers, who are given power to add to their number. All branches of the profession, including editors of several engineering journals, are represented on the committee, which has been selected in order that the town may avail itself of the services of an advisory committee of the "large number of public-spirited engineers of high standing" who live in this suburb of New York. Some years ago, Orange, East Orange and Montclair decided not to join the Passaic Valley Sewerage District in its trunk-sewer project, with disposal in New York Bay. Plans for a disposal plant for the three communities were drawn by Hering & Gregory, New York City, and approved by the State Board of Health. This project has been delayed for various reasons, and there has been considerable talk of separate action by the three communities named.

Philadelphia Rapid-Transit Plans have been curtailed in the modifications announced by W. S. Twining, the present Director of Transit (who recently succeeded A. M. Taylor). The Broad St. subway will be built only from Erie Ave., on the north, to Spruce St., on the south, instead of from Olney Ave. to League Island navy yard. This is a total reduction of about 60 blocks in length. The old plans called for four tracks to City Hall, a delivery loop and two tracks beyond. The new plans call for four tracks from Erie Ave. to Ridge Ave., 4,500 ft. north of City Hall, then two tracks to and under City Hall and to Spruce St. The delivery loop will be partly built as two tracks going south on Ridge Ave. from Broad St. to 8th and to Market St., thence south to Walnut and west to 16th, where they will dead-end for the present. The Broad St. line and the loop will be on different levels at Broad and Walnut St. The Frankford elevated line (to the northeast) will be built to Bridge St., but the Roxborough elevated and subway (to the northwest), the Darby elevated (to the southwest) and all extensions will be left for the distant future. The Keystone Construction Co. has a contract for $1,700,000 of work, a large part of which will not now be done.

The Breaking of the Valve of a gasoline storage tank belonging to the Petroleum Products Co., Neville St., Pittsburgh, on Mar. 10, liberated a great quantity of gasoline, which flooded the surrounding district. Several employees were overcome by the fumes. The gasoline flowed to the sewers and called for quick work on the part of the employees of the Department of Public Works and of the company in lifting the lids from all manholes on the 33d St. sewer between the tank and the river, to allow the fumes to escape. Traffic on the Junction R.R. tracks of the Baltimore & Ohio R.R. was suspended for a time, for fear a spark from an engine might ignite the gasoline fumes. The flow of gasoline was stopped by pumping water into the tank, which displaced the gasoline at the bottom and raised it above the level of the cracked valve. It was along this 33d St. sewer that the disastrous sewer explosions occurred last year in Pittsburgh, and one of the most plausible theories advanced at that time was that gasoline fumes had collected in the sewer from the waste of garages and commercial establishments. There were a dozen or so explosions in homes and sewers of another section of Pittsburgh—the Soho district—earlier in the month, which were generally credited to the leakage of natural gas, although the coroner stated that he would recommend that gasoline waste from garages and other plants be excluded from sewers.

A Contract for Wood Paving Blocks for Minneapolis, calling for 350,000 sq.yd., was awarded on Feb. 28 by K. T. Alexander, city purchasing agent. The blocks will be of yellow pine, 3½ in. deep, creosoted with 16 lb. of oil per cubic foot. The contract price for the blocks is $1.46 per yard, and the contract is divided equally between the Republic Creosoting Co. and the Kettle River Co. The latter shaved its price ⅞c. per sq.yd., to meet the best bid of the Republic Co. Each of the two bidders offered lower prices on half than on the whole contract, under an option given in the advertisement. The price paid by Minneapolis for blocks in 1915 was $1.32. The advance in the 1916 over the 1915 price is said to be less than the increased price of lumber, oil, etc. J. L. Weatherly, of the Kettle River Co., says that the value of the total order will exceed $511,000, strips included, and that the blocks will require 1,000 cars for transportation, will be equivalent to 12,250,000 ft. b.m. of lumber and will pave 22 mi. of 27-ft. roadway. The blocks will be laid by day labor, in accordance with the well-known Minneapolis practice. The cost of the greater part of the 1916 paving will be met under the Elwell law, which makes it possible to allow payments in annual installments extending to as many as 20 years. The maximum under the old law was 5 years. E. R. Dutton, assistant city engineer in charge of paving, is arranging with the Civil Service Commission to increase the number of paving employees from the 400 of last year to 800 or more for the coming season.

PERSONALS

Mr. R. W. Jamison has been appointed City Engineer of Alameda, Calif.

Mr. William R. Roy has resigned as State Highway Commissioner of Washington, on account of ill health.

Mr. George S. Clemens, Pottsville, Penn., has been appointed Consulting Engineer of the Reading Coal and Iron Co., which is a newly created position.

Mr. C. E. Lewars has been appointed Superintendent of the Lebanon, Steelton and Dunbar, Penn., plants of the Semet-Solvay Co., to succeed W. Walley Davis.

Mr. S. B. Fisher, formerly Chairman of the Valuation Committee of the Missouri, Kansas & Texas lines, has been appointed Consulting Engineer of the Missouri, Kansas & Texas Ry.

Mr. Charles H. Swigart, formerly Supervising Engineer of the United States Reclamation Service, has been elected General Manager of the Yakima Valley Fruit Growers' Association.

Mr. Aaron Lloyd has been appointed Superintendent of Construction on the new state bridge at Spring City, Penn., by the Pennsylvania Board of Public Grounds and Buildings.

Mr. Chester A. Hogentogler, formerly Engineer for the Borough of Columbia, Penn., has been elected Assistant Professor of Civil Engineering at the University of Idaho, Moscow, Idaho.

Mr. Charles E. Barba, Assistant Engineer in the Mechanical Department of the Pennsylvania R.R. at Altoona, Penn., has resigned to become associated with the Midvale Steel and Ordnance Co.

Mr. F. Herbert Snow, M. Am. Soc. C. E., Chief of the Engineering Division of the Pennsylvania Public Service Commission, has been made professional lecturer on public utilities at Pennsylvania State College.

Mr. J. R. Nichols has been appointed Manager of the new office of the Asbestos Protected Metal Co., in the Hurt Building, Atlanta, Ga. Mr. Nichols has been associated with the company for a number of years at its Chicago office.

Mr. James B. Walker, formerly Assistant Secretary of the New York State Public Service Commission for the First District, has been appointed Secretary of the commission, in the place of Travis Whitney, who is now a member of the commission.

Mr. G. O. Case, M. Am. Soc. C. E., Chief Engineer of the Case Coast Protection Corporation, New York City, sailed on Mar. 4 for Georgetown, British Guiana, for the purpose of making a report to that Government on the erosion of the country's coast.

Mr. B. J. Dalton, M. Am. Soc. C. E., formerly Assistant District Engineer, Division of Valuation of the Interstate Commerce Commission, has been appointed Chairman of the Valuation Committee of the Missouri, Kansas & Texas lines with headquarters at Parsons, Kan.

Mr. Charles Enzian, M. Am. Inst. M. E., formerly Mining Engineer of the Anthracite District of the United States Bureau of Mines at Wilkes-Barre, Penn., has been appointed Mining Engineer of the Shenandoah and Mahanoy division of the Reading Coal and Iron Co.

Mr. A. C. Shields, formerly Division Engineer of the Chicago, Rock Island & Pacific Ry., at Little Rock, Ark., has been appointed Division Engineer of the Missouri division, with offices at Trenton, Mo. He succeeds F. E. Watson, who has been granted a leave of absence.

Mr. T. R. Galey has been appointed Manager of the new office of the Asbestos Protected Metal Co., of Pittsburgh in the Praetorian Building, Dallas, Tex. Mr. Galey has been associated with the company for the past four years, two of which were spent at the Beaver Falls factory.

Matthew J. Scammell, Superintendent of Blast Furnaces at the Sparrows Point, Md., plant of the Maryland Steel Co., has been made General Superintendent, a position formerly held by Quincy Bent, who has been made General Manager at the Steelton, Penn., plant of the Pennsylvania Steel Co.

Mr. Albert A. Northrop, M. Am. Soc. C. E., formerly of the firm of Seabury & Northrop, New York City, and more recently Supervising Engineer of Stone & Webster, will sail on Apr. 1 for Montevideo, Uruguay, where he will be connected with the construction of sewage-disposal and water-supply systems for several cities in Uruguay. His headquarters will be at Montevideo.

Mr. Paul Hansen, M. Am. Soc. C. E., for the last few months Acting Chief Engineer of the Illinois State Board of Health, has been appointed Chief Engineer. Mr. Hansen is a graduate of the Massachusetts Institute of Technology. He has been successively Assistant Engineer of the Ohio State Board of Health, Engineer of the Kentucky State Board of Health and Chief Engineer of the Illinois State Water Survey. His headquarters will be at Springfield, Ill.

Mr. R. Boone Abbott, Division Engineer of the Philadelphia & Reading Ry. at Harrisburg, Penn., and President of the Engineers' Society of Pennsylvania, has been appointed Superintendent of the Shamokin division of the road, with headquarters at Tamaqua. Mr. Abbott entered the service of the Philadelphia & Reading in 1900. Soon after he was made Assistant Supervisor at Tamaqua and after various promotions became, in 1910, Division Engineer at Harrisburg.

Mr. Robert N. Hoyt, for the past two years administrative officer at Wellesley, Mass., in the experiment whereby adjoining towns combine in the establishment of a high-grade health office to serve them all, has been appointed Health Officer of Manchester, N. H. Mr. Hoyt was formerly Biologist of the Metropolitan Sewerage Commission of New York City and, later, for a time was Health Officer of Princeton, N. J. Mr. Hoyt graduated from the Massachusetts Institute of Technology in 1909.

Mr. James Allen, Chief Engineer of the Washington State Highway Commission, has been appointed State Highway Commissioner to succeed Mr. William R. Roy, who has resigned. The position pays $5,000 a year. Mr. Allen has been Chief Engineer since 1913, previous to which time he was locating engineer in the State Highway Department (in 1909) and later Chief Engineer of the Olympia Light and Power Co. Mr. Allen has also been connected with the Oregon Short Line R.R., the Northern Pacific Ry., the Missouri Pacific System and the Chicago, Milwaukee & St. Paul Ry.

Mr. C. B. Lamont, M. Am. Soc. M. E., Manager and Consulting Engineer of the Skinner-Eddy Corporation of Seattle, has resigned as Manager of the company and opened offices in the Hoge Building, Seattle, where he will practice as a consulting engineer. He will continue as Consulting Engineer of the Skinner-Eddy Corporation and in addition to his consulting work in the shipbuilding line will conduct a ship-brokerage department. Mr. Lamont, previous to his association with the previously named concern, was Assistant to the President of the Seattle Construction and Drydock Co.

Mr. George F. Cotterill, former Mayor of Seattle and former member of the state senate, has been appointed Chief Engineer of the Washington State Highway Commission to succeed Mr. James Allen. The position pays $3,600 a year. Mr. Cotterill has lived in Seattle since 1883. He is a charter member and was the first secretary of the Northwest Society of Engineers. He was Assistant City Engineer from 1892 to 1900, during which period he did a considerable amount of work in the development of the city water-supply. In 1902 he became a member of the firm of Cotterill & Whitworth and in 1910 dissolved partnership and specialized for many years in park and landscape platting. He was Mayor from 1912 to 1914.

Mr. Sydney O. Swenson, M. Am. Inst. E. E., for the past four years Electrical Engineer of the Kansas City Terminal Railway Co., in charge of all electrical work pertaining to the new union station and terminal facilities, has become a member of the Engineering Offices of Putnam A. Bates, 2 Rector St., New York City. Previous to his work at Kansas City Mr. Swenson was Assistant Electrical Engineer of the Detroit River Tunnel Co. and was engaged on all engineering work in connection with the electrification of the Michigan Central R.R. at Detroit, Mich., and Windsor, Ont. After graduation from the University of Illinois in 1899 he spent six years in the engineering department of the Commonwealth Edison Co. of Chicago and later was engaged on the electrification of the New York Central R.R. at New York City.

OBITUARY

George A. Gilfillan, M. Am. Soc. C. E., Consulting Engineer of Pittsburgh, Penn., died at Battle Creek, Mich., on Mar. 13. He was 51 years of age.

Carl G. Eyssell, President of the M. Eyssell Construction Co., St. Louis, Mo., died in that city on Mar. 10, at 26 years of age. Mr. Eyssell recently succeeded his father as President of the company.

Charles Jephtha Hill Woodbury, M. Am. Soc. M. E., Consulting Engineer, of Boston, died at his home in Lynn, Mass.,

on Mar. 20, at 64 years of age. Mr. Woodbury was a graduate of the Massachusetts Institute of Technology. He was Engineer, and later Vice-President, of the Manufacturers' Mutual Fire Insurance Co. In 1894 he was made Assistant Engineer of the American Bell Telephone Co. and remained with the company until 1907. Mr. Woodbury was Manager of the American Society of Mechanical Engineers from 1882 to 1885. He was Secretary of the National Association of Cotton Manufacturers.

Frederick C. Stevens, who has appointed Superintendent of Public Works of the State of New York by Ex-Governor Hughes, died at his home in Attica, N. Y., on Mar. 14. Mr. Stevens was elected state senator in 1902. He served as Chairman of the joint committee appointed to investigate the operation of the New York City gas and electric companies and selected Mr. Hughes as counsel for the committee. Following the successful outcome of the investigation by the committee, Mr. Hughes was appointed counsel of the insurance investigation, and upon his election as Governor of New York State he chose Mr. Stevens as Superintendent of Public Works. Mr. Stevens was 64 years old.

Robert M. Jones, an engineer of Denver, Colo., died suddenly on Mar. 1 at Carlsbad, N. M. He was born in Wayne, Ohio, in 1853 and began his engineering career as a United States Deputy Surveyor in locating township and territorial boundaries, principally in New Mexico, Indian Territory and Wyoming. For this work, in 1880, he applied the Burt solar attachment to the engineers' transit and patented the Jones latitude arc for observing latitude at any time of day. In 1883 Mr. Jones became associated with the Edison Electric Illuminating Co. and built a steam plant at Laramie, Wyo., and in 1889 went to Salt Lake City, where he built the three original systems and steam-power plant. He also built two electric-railway systems in Montana. He invented and for a short time manufactured an electric rotary diamond drill. During the 1893 panic Mr. Jones financed and began constructing the Big Cottonwood "Stairs" hydro-electric plant to supply power to Salt Lake City, which is still operating as part of the Utah system. He located and partly constructed the first plant of the Nevada-California Power Co. on Bishop Creek, Calif., for supplying power to the Goldfield and Tonopah mining districts in Nevada. Since 1906 Mr. Jones had maintained an office in Denver, acting as engineer in examination and design of many hydro-electric projects throughout the West and in Mexico. For several years past he had devoted much of his time to the development of a process for making hollow reinforced-concrete poles, piles and pipe without the use of forms. At the time of his death Mr. Jones was engaged in making repairs on the Tansill dam on the Pecos River at Carlsbad.

ROBERT M. JONES

William Howatt, who designed and supervised the construction of the belt-line tunnel of the Baltimore & Ohio R.R. at Baltimore, Md., died at Youngstown, Ohio, on Mar. 16, at 74 years of age. He was born near Glasgow, Scotland, and educated in the University of Edinburgh. He came to America in 1866 and settled in Braddock, Penn. His first service was with the old Pittsburgh & Connellsville R.R. He later became Chief Engineer of the Pittsburgh division of the Baltimore & Ohio R.R. After the completion of the belt-line tunnel Mr. Howatt was Chief Engineer and Superintendent of Public Works of Braddock, in which position he remained for 17 years, and then he returned to the Baltimore & Ohio, remaining with that railroad for six years. About 10 years ago he was appointed head of the Public Works Department and Borough Engineer of Braddock, resigning two or three years ago.

Erasmus Darwin Leavitt, M. Am. Soc. M. E., died at Cambridge, Mass., on Mar. 13. He was born in Lowell, Mass., in 1836 and was educated in the Lowell public schools. He served for three years as apprentice in the machine shop of the Lowell Manufacturing Co. and was for one year with Corliss & Nightingale. He was later Assistant Foreman of the City Point Works in South Boston and had charge of building the engines for the flagship "Hartford." From 1859 to 1861 he was Chief Draftsman for Thurston, Gardiner & Co., Providence, R. I. He served through the Civil War, during which period he was detailed to the Naval Academy at Annapolis as instructor in steam engineering. In 1867 he resumed the practice of mechanical engineering, specializing in pumping and mining machinery. He was Consulting Engineer of the Calumet & Hecla Mining Co. from 1874 to 1904, during which time he designed and superintended the equipment now used at Calumet. He was also Consulting Engineer for Henry R. Worthington, the Dickson Manufacturing Co. and the Cities of Boston and Cambridge and designed the pumping engine for the City of Louisville, Ky. He was advisory and designing engineer for the Bethlehem Steel Co. and several South African mining companies. Mr. Leavitt was President of the American Society of Mechanical Engineers in 1883 and was a member of numerous other national and international technical societies. In 1884 he received the honorary degree of Doctor of Engineering from Stevens Institute of Technology. He retired from active practice in 1904.

Lightner Henderson, Chief Engineer of Purdy & Henderson, Civil Engineers, died at Chicago, on Mar. 17. He was born at Lancaster Gap, Penn., in 1866. In 1889 he graduated from Lehigh University. He worked as structural-steel draftsman and designer until 1891, when he was employed by C. T. Purdy, Consulting Engineer, Chicago, two years later being taken into partnership. Among the prominent structures the design of which was vitally influenced by Mr. Henderson, are the Flat Iron, Whitehall, Metropolitan Tower, Waldorf-Astoria, Hippodrome, Pennsylvania R.R. Station in New York City, New York County building, Marquette building, Montgomery-Ward Tower, Congress Hotel of Chicago, University Club of Chicago, Wabash Terminal of Pittsburgh, New Willard Hotel of Washington, Jefferson County Savings Bank of Birmingham (Ala.) The exposed steelwork in the Concourse of the Pennsylvania Station (New York), the design of which steel was conceived by Mr. Henderson, probably is the most generally admired piece of structural work in the country. C. T. Purdy, his partner, speaks of Mr. Henderson thus: "He had an exceptionally fine analytical mind, and judgment always reliable. He possessed, more than any other man in the country, the faculty of combining theoretical analysis with consideration for the practical, which is so necessary to the highest development in structural-steel designing. He was gifted with a genius for simplicity, coupled with accuracy and reliability. In his relations with other men, right was his primary objective. He was beloved by associates and employees." Mr. Henderson was a member of the Western Society of Engineers and of the Engineers' Club, Chicago. He is survived by a widow and two daughters.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 28 to Mar. 3. Annual convention in Pittsburgh. Secy., E. L. Powers, 150 Nassau St., New York City.

ENGINEERING SOCIETY OF WISCONSIN.
Feb. 25-26. Annual meting in Madison. Secy., L. S. Smith, Madison, Wis.

CONFERENCE ON ENGINEERING CO-OPERATION.
Apr. 13-14. Conference in Chicago. Secy., C. E. Drayer, Cleveland, Ohio.

AMERICAN CHEMICAL SOCIETY.
Apr. 18-21. Annual meeting at the University of Illinois, Urbana-Champaign. Secy., Charles L. Parsons, Washington, D. C.

Engineers' Society of Pennsylvania will hold its second annual banquet at the Harrisburg Club on Mar. 25. The banquet will be in celebration of the twelfth anniversary of the founding of the society, which now has a membership of nearly 800. Henderson Gilbert, Harrisburg, will be toastmaster, and the speakers will be as follows: A. T. Dice, vice-president and general manager of the Philadelphia & Reading Railway Co.; Frederick W. Fleitz, former deputy attorney general of Pennsylvania; Colonel Biddle, of the United States Army Engineer Corps; J. V. W. Reynders, former vice-president and general manager of the Pennsylvania Steel Co., and Quincy Bent, general manager of the Steelton plant of the Pennsylvania Steel Co., formerly assistant to President F. W. Wood of the Maryland Steel Co. The keynote of the addresses will be "Preparedness" from the industrial and engineering viewpoint. The committee in charge includes, Charles E. Ryder, chairman; Mier G. Hilpert, R. L. Gillespie, H. P. Drake, Henry S. Evans, George S. Relae, W. Gard Conklin, William McCreath, Edward J. Bevan and R. Boone Abbott, president of the society.

Appliances and Materials

Motor Tractor with Towing Winch

A new design of tractor, known as "Model 36," has been put out by the Knox Motor Associates, Springfield, Mass., the special feature being a powerful winch on the rear of the tractor frame for use in wrecking, hoisting, logging or heavy haulage over bad ground. Except for the added features incidental to towing and winch haul and use with four-wheeled trailers only, this tractor is like the earlier "Model 35" described in "Engineering News," Mar. 11, 1915, with hydraulic brakes, locking differential, etc.

The winch is equipped with 150 ft. of cable and is driven from a power attachment on the transmission through a propeller shaft and two universal joints to a worm and gear on the winch shaft. The winch drum is loose on the shaft and is driven through a clutch that may be released by hand when it is desired to reel off the cable. With the motor running at 1,000 r.p.m. the cable is hauled in at 40 ft. per min. When it is desired to operate the winch, it is of course necessary to anchor the tractor itself; and to supply this anchorage, a heavy sprag is attached to the rear axle. The tractor

KNOX TRACTOR WITH TOWING WINCH

can tow in either direction. At the rear of the tractor frame a large forged-steel towing hook is attached, and a heavy buffer spring is inserted to absorb the shock of sudden starting. Two front hooks enable towing backward or anchoring the tractor in addition to use of the sprag. The tractor chassis is designed to support a weight of from 2 to 4 tons in any form of body that may be desired, thus insuring the necessary degree of traction and enabling the tractor to act as a carrying as well as a hauling vehicle. Steel wheels are also provided at small additional cost, either as a substitute for the standard rubber-tired wheels or as extra equipment.

Where the tractor has to haul a heavily loaded trailer or a train up an abnormal grade, the trailer wheels can be blocked, the tractor run ahead 150 ft. and anchored by the sprag; a 20,000-lb. drawbar pull exerted through the winch can then be utilized to bring up the load. In bad going the winch may also be used to pull the tractor or trailer up on solid ground when either has become mired. The price of this machine is $5,000.

* * *

Bituminized Paving Brick

Under the trade name "Aspha-Bric" there is being brought out a paving brick saturated with bituminous compound. The bricks are ordinary side-wire-cut vitrified, with a minimum crushing strength of 3,500 lb. per sq.in. In the process of being bituminized they are piled on pallets, run into a preheating chamber (400° F.) for 2 to 4 hr., transferred to a truck and run into a large pressure tank. Here they are subjected first to a 25-in. vacuum for 1 hr. and then covered with melted asphalt (350° F.), which later is subjected to 160-lb. pressure for 2 hr. Finally, the asphalt is run off, and the bricks are cooled under pressure.

Standard rattler tests of these treated bricks were run at the University of California and showed a loss of 8.3%. The absorption was 0.3% after 24 hr. submersion. Heating to 225° F. for 48 hr. showed no weight loss. Analysis of a sample of pulverized brick showed 11.2% bitumen. The total cost of these bricks, as produced at Oakland, Calif., is reported to be $10.20 per M. It is claimed that the treated bricks resist abrasive wear better and have a better bond to each other and to their foundation than the untreated. The process is controlled by the Aspha-Bric Corporation, 540 Otis Building, Chicago.

* * *

Inkwell for Drafting Pens

An inkwell with a valve point for filling the drafting pen, designed to save time and simplify the operation by making it a one-hand movement, is made either as illustrated or with two wells on a common base casting. It has a porcelain well basin, with a hard-rubber valve case screwed into the lower

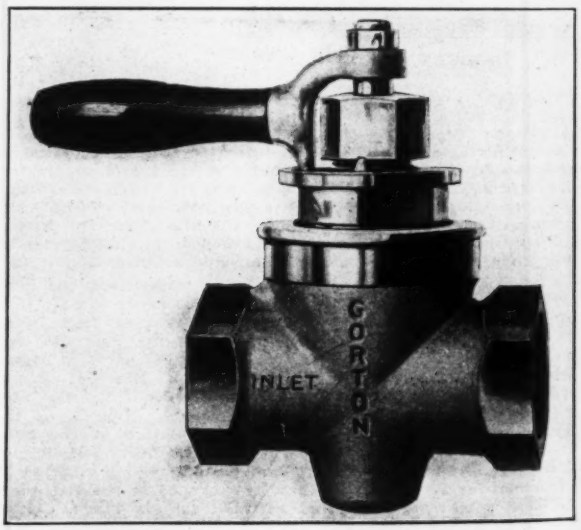
DRAFTSMAN'S INKWELL

part. The valve is a pointed plunger pushed downward by a light spring. When pushed up by the draftsman's pen, it lifts a small quantity of ink and then allows this to run down around the plunger point to fill the pen. The Allen Co., 221 Columbus Ave., Boston, is the maker of this device, called the "Quickfil" inkwell; the cost is $2 single, $3.75 double.

* * *

Radical Departure in Valves

A new departure in the design of steam and water valves has been developed by the Gorton-Lidgerwood Co., 96 Liberty St., New York City. The new type is adapted for all services, but work has been completed as yet only on the ½- to 1½-in. straightway and radiator valves. The body is of bronze ("steam metal") reamed to receive a ground taper plug of a special molded mineral composition which, it is claimed, is indestructible and has no temperature or service distortion. A full-sized through port is molded in the plug, and a quarter turn opens or closes. The plug is held to its seat by a bronze spring under the cap or bonnet. The valve stem engages the plug through a loose joint, to prevent possible unseating. No packing is required for the stem, but a molded asbestos ring in a simple gland is used as added precaution.



GORTON QUARTER-TURN VALVE

The large size and free way of the steam or water passage allow the use of a size smaller valve than is customary in many cases. Valves of this type are made to sell at standard list prices (running from $2.40 for a ¾-in. straightway to $6.60 for a 1½-in.) in small quantities, but can be produced in large numbers to compete with the older types.

Engineering News

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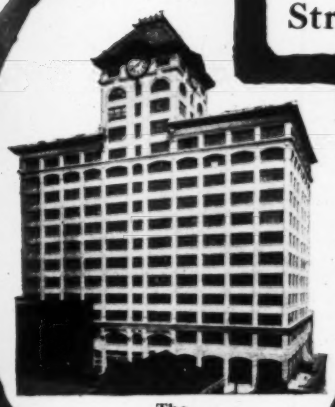
The Largest Concrete Structures of Their Kind



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275 ft. high.

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Middleboro Concrete Water Tower-Tank.
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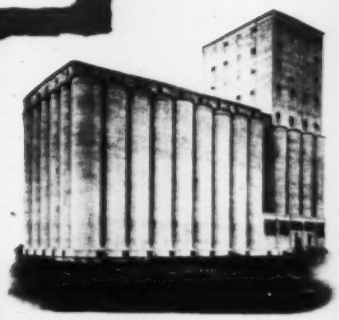
C. E. Hennibique Construction Co., N. Y., Contractors.



Grain Elevator and Storage Bins
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James Stewart & Co. Contractors
Havemeyer Bars
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Agencies and Stocks in Principal Cities

Final Proof of Satisfaction from Lackawanna Steel Sheet Piling in the Cofferdam for the 46th Street Piers, New York.

THE CITY OF NEW YORK
DEPARTMENT OF DOCKS AND FERRIES
OFFICE OF THE CHIEF ENGINEER

CHARLES W. STANIFORD, CHIEF ENGINEER

PIER A, NORTH RIVER Dec. 22, 1915.

The Lackawanna Steel Co.,

Gentlemen:

The 3500 tons of Lackawanna Steel Sheet Piling used in the cofferdam for building the foundations and excavating the slips at the shore ends of the 46th Street piers has proven eminently satisfactory in every respect. The maximum length of these steel sheet piling sections was 73 feet, yet driving involved no particular difficulties, the driving costs being very reasonable. The longitudinal, transverse and joint strengths of the individual sections have proven ample to meet our severest requirements.

The fact that this 300 by 800 foot cofferdam after unwatering, has been kept dry by a 12-inch pump is good evidence of the watertightness of the Lackawanna type of interlocked joint, this small amount of pumping being necessary only on account of a cribwork at the north end, and from two sheet piles in the larger cylinders at the south end striking a boulder. The whole 800 feet of exposed river face is absolutely dry.

Yours truly,

Chas. W. Staniford

Chief Engineer.

This 46th Street Pier Cofferdam, the one for raising the United States Battleship Maine, and the one in which the Black Rock Ship Lock at Buffalo was built, are the three largest and by far the most important steel sheet piling structures on record—and *all three* owe *their* success to the *exclusive* use of Lackawanna Steel Sheet Piling. Tests under United States Government supervision and the above unqualified endorsement from the Chief Engineer of the Department of Docks and Ferries of the City of New York further confirm the superiority of our design.

Put yourself on the safe side by lining up with the leader, and profit also from our free engineering co-operation.

Our book "Lackawanna Steel Sheet Piling" is free to managing engineers.

LACKAWANNA STEEL COMPANY

General Sales Office and Works: Lackawanna, N. Y.

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Engineering News

VOLUME 75 MARCH 30, 1916 NUMBER 13

Seattle Water-Works Troubles

By Charles Evan Fowler*

SYNOPSIS—Experience with wood-stave supply mains has justified their adoption, notwithstanding lack of proper maintenance. Delays in carrying out plans for additional storage have been due in part to a struggle over municipal ownership of the electric-light and power plant associated with the water-supply and in part to the failure of the city government to follow sound engineering advice. The leaky basin back of the new Cedar River dam should be sealed, a more comprehensive method for maintaining the wood-pipe lines adopted, the wood pipe gradually replaced with steel or concrete, more storage at the city end of the supply lines provided and a separate high-pressure water-supply system constructed for fire protection in the business district.

The history of Seattle's water-works system is of interest to engineers and cities, especially those in the West, due to the varied experiences related in this article.

The Spring Hill Water Co. in 1881 built the first Seattle water-works worthy of the name, and in 1888 Robert Moran, mayor, and afterward builder of the battleship "Nebraska," recommended the purchase of this and other systems and their merger in an adequate city-owned system, most of which was to be built new. The details were covered quite fully in a report of the then city engineer, the late John G. Scurry, and the system was purchased in January, 1890, for $352,266.

The city employed as chief engineer to plan the new system Benezette Williams, who began his investigations in the fall of 1889. While he recommended bringing the water from Cedar River, a distance of 29 mi., his principal recommendation was to empty it into Swan Lake, 17 mi. from the city (see map, Fig. 3), using this as the principal storage and equalizing reservoir. His report stated that the lake would afford a daily storage of 25,000,000 gal. for a period of 70 days, or a total of 1,750,000,000 gal. as compared with the present capacity of about 270,000,000 gal. for all the present reservoirs and standpipes in the city.

The supply main to the city was to be of 42-in. wood-stave pipe coated with two coats of hot asphaltum, which Mr. Williams contemplated as having an indefinitely long life and as costing $7.50 per lin.ft. The estimate at that date for cast-iron pipe was $15 and for steel riveted pipe $10 per lin.ft. The total cost of the proposed system was estimated to be about $1,200,000.

*Consulting Engineer, Central Building, Seattle, Wash.

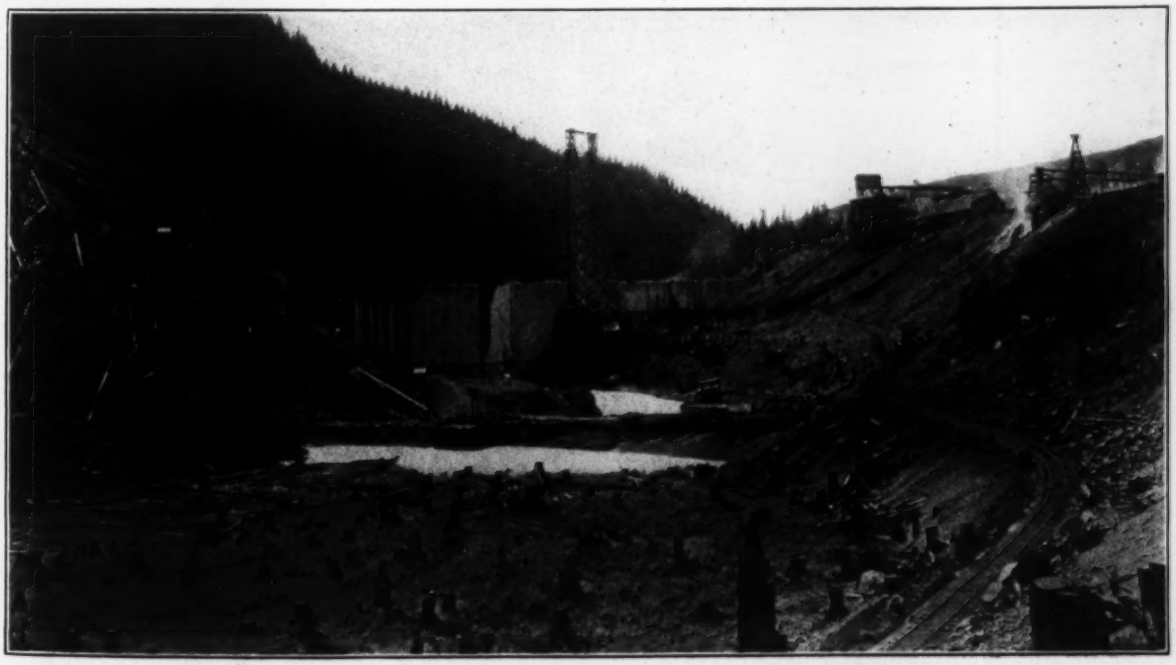


FIG. 1. CEDAR RIVER MASONRY DAM AND LOWER END OF MORAINAL DIKE ON RIGHT

The business depression of the 90's caused the project to lie dormant until 1895, when surveys and plans were begun for the present system by R. H. Thomson, city engineer. There was appropriated the sum of $1,000 for the engineering work! Nothing daunted, Mr. Thomson put all his regular force to work on the surveys, and they were completed during 1896-97 for the small sum of $8,601.

The great future of Seattle seems to have been fully realized by this engineer, who immediately saw the futility of using Swan Lake at the great additional cost for the then comparatively moderate results obtained and decided upon carrying the entire supply from Cedar River direct to Seattle.

The log-crib dam on Cedar River gives a storage capacity of 5,400,000,000 gal. and the permanent dam 43,000,000,000 gal. The contract was let in April, 1899, for pipe line No. 1 and the Volunteer and Lincoln Park reservoirs, with a capacity of 46,000,000 gal., at about $1,250,000.

Pipe line No. 1 has a length of 28.57 mi., of which 6.82 mi. is of 42-in. steel pipe and 21.7 mi. of untreated wood pipe ranging from 42 to 44¼ in. in diameter for most of its length. This line delivers 22,500,000 gal. per 24 hr., with a velocity of 3.6 ft. per sec. It cost $322,952 and up to 1916 there had been spent in maintenance $128,858, or 40% in 15 yr., as against the estimated cost for renewal of $311,294, or about 65%.

The water department estimated on this relining twice in 45 yr., or the same period as the assumed life of a steel pipe, which was estimated to cost $3,360,352, as against $1,947,595 to be spent in 45 yr. for the wood pipe, figuring interest at 5%. The difference in favor of wood pipe was $1,413,756.

The fact became evident as early as 1906 or 1907 that it would be necessary to increase the water-supply of the city, and the sum of $2,250,000 was spent for pipe line No. 2, for the two Green Lake reservoirs and the twin reservoir on Beacon Hill, with a combined capacity of 220,000,000 gal.

Second Wood-Stave Supply Main

Water was delivered from this line in June, 1909. Its total length is 34.04 mi., of which 5.32 mi. is of steel, principally of 42-in. diameter, and 28.72 mi. of untreated wood-stave pipe, chiefly of 42-, 51½- and 60-in. diameters. The amount delivered by pipe line No. 2 is 41,770,000 gal. in 24 hr., at a velocity of 4.8 ft. per sec. The sum spent on maintenance of this line up to 1916, or a period of 6½ yr., has been only $18,207. This expenditure was abnormally large by reason of nearly $6,000 damage to bridge and line in 1911 and 1912. Leaving out this item, the cost of maintenance has been less than 2% for this period, and it is safe to assume that it will not exceed for the 15-yr. assumed period the 40% charges against pipe line No. 1, as noted above.

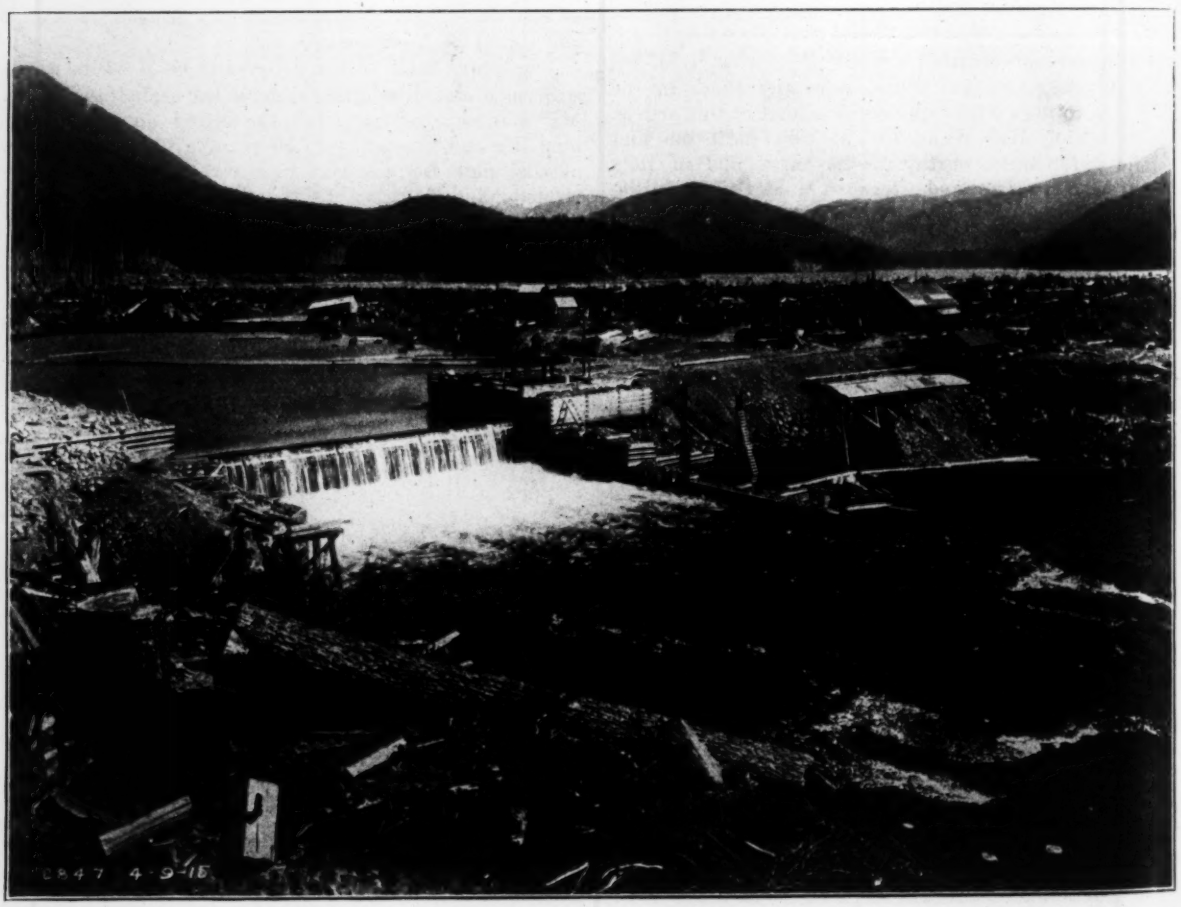


FIG. 2. OLD LOG-CRIB DAM ON CEDAR RIVER AT LANDSBERG; SEATTLE WATER-SUPPLY

These pipe lines both extend from the same intake at Landsburg, El. 535.83, to Seattle and discharge at El. 420. The cost of the pipe has been about as follows per lineal foot:

	42-In.	51½-In.
Staves	$0.85	$1.03
Bands	1.82	2.36
Shoes	.29	.29
Excavation and fill	.55	.72
	$3.51	$4.40

This estimate assumes 25 to 27 staves for the 42-in. pipe, 32 staves for the 51½-in. and three bands ⅝ in. in diameter per foot of pipe. The actual cost of renewing 1,600 ft. of pipe in June, 1913, was $1,330 for labor at $2.75 per day and $1,516 for material. Per foot of pipe this is $0.83 for labor and $0.95 for material, or a total of $1.78.

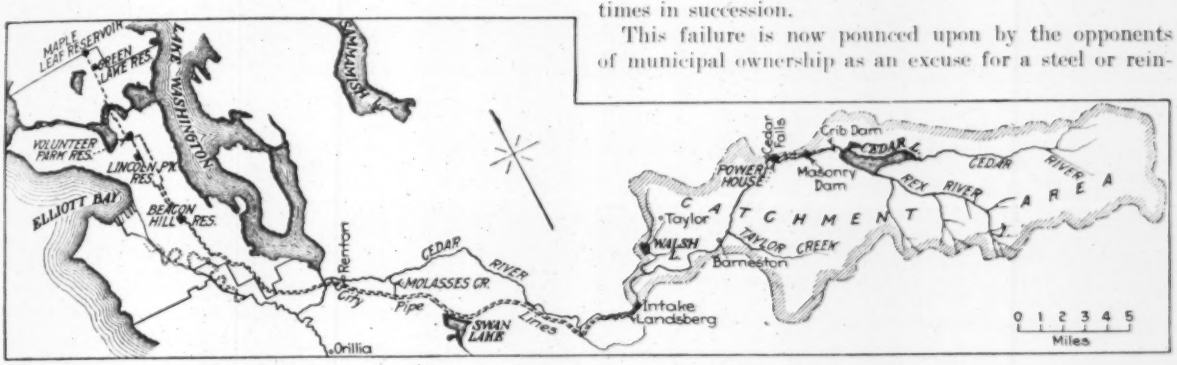


FIG. 3. MAP SHOWING DAMS, PIPE LINES AND RESERVOIRS, CEDAR RIVER WATER-SUPPLY, SEATTLE

Municipal Ownership of Light Plant

The various troubles that have occurred are largely of such a degree as must be expected in any great public enterprise, but they did not become the subject of public controversy until the municipal light plant was built—to generate power and light from the stored waters of Cedar Lake, the plant being located between the dam and the intake of the pipe lines at Landsburg. Since then every happening and proposed expenditure has been the subject of violent controversy between the advocates of municipal ownership on the one hand and the advocates of the private interests on the other hand, with which the city light plant competes for light and power.

The beginning of the great masonry dam (*Engineering News*, Jan. 21, 1915) was long delayed by the fight to prevent an increase in the available power, and the attempt to seal the leaky basin back of the dam is being delayed, it is charged, for like reason. Unquestionably, there is no good reason why an attempt should not be made to seal it, and there is no good reason why it cannot be successfully and cheaply accomplished.

There is danger that the old log-crib dam may fail at any time and let the impounded waters dash against the new dam farther down the cañon. Should that fail as a consequence, then Seattle's water situation would be serious indeed; but the writer is of the opinion that it would stand, and then the leaky basin might make trouble. There is every possibility, however, that in such an event the sediment carried down from the old lake would seal the pervious morainal dike (Fig. 1) and cure this defect.

The break in the pipe lines in November, 1911, when the bridge carrying the pipes across Cedar River washed out, lasted for six days and one hour (see *Engineering News*, Dec. 14, 1911, p. 706). It was permanently repaired with a new bridge and extensive bank protection and is not likely to occur again.

Third Supply Main Not Needed

The recent breaks (*Engineering News*, Jan. 20, 27, Feb. 3, 1916) were the cause of several days' delay and a dangerous shortage of water. They were not caused by the wood pipe primarily, but because the standpipes were frozen up and the pipe could not get air, hence the collapse from external pressure. The workmen failed to learn the lesson, and the same thing happened several times in succession.

This failure is now pounced upon by the opponents of municipal ownership as an excuse for a steel or reinforced-concrete pipe and other reservoirs at a cost of $3,000,000, whereas it is only necessary to effect a more efficient organization for the care, maintenance and repair of the wood pipe. Should this amount be expended, there is little hope for the completion of the basin back of the new dam and the extension of the light and power department from this source for many years, with many sections of the city really suffering for lights.

The recent project would also include the raising of Swan Lake 16 ft., to create a storage basin of 13,500 acre-ft., or 4,410,000,000 gal. This work would entail the construction of the necessary inlet pipes to the lake, the dredging out of the lake, the construction of a dam and of a permanent aqueduct about 17 mi. long into the city. John R. Freeman has already pointed out the possible trouble in getting pure water from Swan Lake and has recommended careful expert study of this question.

Should steel pipes be used for the proposed permanent line, they would collapse under such treatment as was given the wood-stave line; and unless a reinforced-concrete pipe was designed for such a great external load, it too would collapse.

Time for Adoption of Engineering Program

While it is doubtful, judging from past experience, whether the city will take time to have the question properly studied by experts, there is no reason for making the great expenditure proposed, especially under present financial conditions. The real lesson to be learned is the need for a more efficient business administration and one that is closer to the people and single to their interests. The summing up of all the foregoing logically calls for carrying out the following program of betterments:

1. The sealing of the basin back of the new dam at the earliest possible moment, in order to retire the old log-

crib dam, to make available a greater storage and to make available more electrical energy for light and power. This should be done after careful study by expert engineers and the adoption of a definite scheme laid down by them.

2. The gradual replacement of one or both pipe lines by a permanent aqueduct of steel or concrete. This would include the relocation of some parts of the line at danger points, with some of the new line in tunnel.

3. Where repairs are made on the wood-stave lines, some more comprehensive method than is used at present should be adopted for protecting the top surface of the pipe with hot asphalt, as recommended by Benezette Williams, or by some other suitable method—especially at the summits, where air collects and hastens decay.

4. The acquiring of Swan Lake and its watershed, the careful study by experts as to its inclusion in the system and the carrying out of such a plan in the future, when financial conditions are favorable.

5. The immediate construction of an additional reservoir in Volunteer Park and the erection of standpipes for West Seattle and other locations, as needed.

6. The immediate construction of a separate system of high-pressure water mains for fire protection in the business district.

The foregoing outline of betterments is based on the facts that there is nothing vital the matter with the system as it stands, for present needs, and that it is unnecessary and inadvisable at this juncture to spend $3,000,000 for new construction.

Large River Wall of Unusual Design at Cedar Rapids

SYNOPSIS—Reinforced-concrete river wall designed to meet variety of loading conditions. Concrete dumped 20 to 30 ft., then tamped. Wall panels covered by sheet metal. Double stairways to lower walkway, placed between bridges. An ornamental balustrade, the spindle of which can be easily cast.

Two city blocks of heavy reinforced-concrete wall are being completed along the Red Cedar River, at Cedar Rapids, Iowa—from the concrete bridge at Third Ave. to that at Second Ave., and between the latter and an old iron bridge at First Ave. This work is part of an extensive city plan proposed by the local River Front Improvement Commission. A typical section through the wall, Fig. 1, shows it to be of the counterforted type, with a low walk on the river side for the use of boatmen and a high-level walk on the shore side to be used as a walkway. The lower walk is supported on occasional piers and the upper one on brackets extending out from the counterforts. In the design of the wall the stability was investigated under the following assumed conditions:

1. Water to be low, reaching an elevation of 1 ft. below the top of the river sidewalk, and the earth-fill to be level with the top of the upper sidewalk.

2. Same condition as 1, but with a footing of a three-story (basement) building placed 10½ ft. back from the face of the wall and 12 ft. below the top of the upper sidewalk.

3. With no earth-fill behind the wall and with river at an elevation approximately 20 ft. above the bottom of the footing, the drain holes through the wall to be open so that water from the river can rise to the same level back of the wall.

4. Same condition as 3, except that the drain holes are assumed to have been closed so that no water can get from the river to the rear of the wall. This assumes that there would be neither earth nor water back of the wall in this particular case.

The wall is designed to take earth pressure on an angle of repose of 35°, with level fill. A vertical load is assumed of 14,000 lb. per lin.ft. applied 12 ft. below the surface of the upper walk and 10 ft. 6 in. back from the face of the wall, to provide for possible building footings.

The wall is carried on a 2-ft. slab foundation, 15 ft. wide, resting on blue clay. Two projections have been provided to prevent sliding, one at the front and one at the rear edge of the footing. The maximum footing pressure is about 2 tons per sq.ft. The front slab is reinforced front and back, and the footing is reinforced top and bottom, for double pressure. Extensive drainage of ground water is provided by 6-in. vitrified tile placed at the corner of every counterfort and extending from the top of the footing to the top of the wall. Every other length is a tee, the outlet being flush with the rear face of the counterfort and the opening covered with ½-in. mesh copper screen.

An old concrete-building foundation, located just south of the Second Ave. bridge, encroached upon the site of the wall. Either it would have to be blasted out or the wall foundation would have to be modified to include the obstruction. As the footing was 60 ft. long by 6 ft. deep by 4½ ft. wide, it was decided to build over and around it, as shown in Figs. 1 and 4.

Erecting Forms and Placing Concrete

The footings were poured without using sheeting, the blue clay being impervious. An earth coffer-dam had previously been thrown up, with a centrifugal pump (4-in. discharge) to handle the leakage in the foundation pit. First, the bottom was prepared, and the space for the cutoff walls was cut out.

A 1:2:4 mix was used, which included river sand and stone from the local Ellis Park quarry. River sand and crusher screenings were mixed in careful proportions to give a mixture of sand closely approximating Fuller's curve of maximum density. The consistency of the concrete was the usual chuting mix. The concrete for the footings was deposited by chute either directly from the

mixer or by wheeling it in buggies from mixer to chute. The vertical drop was about 26 ft. To overcome resulting separation of the aggregate, a gang of men worked the concrete about with shovels before allowing it to set.

Reinforcement stubs were placed in the footings, to provide for splicing all vertical steel in the main wall. A lap of at least 40 diameters was specified. Whenever this was impossible, which it was in a few instances, the stubs were given better than a 90° hook in the concrete.

Forms for the vertical portion of the wall and for the counterforts were set up on the footing slab after the

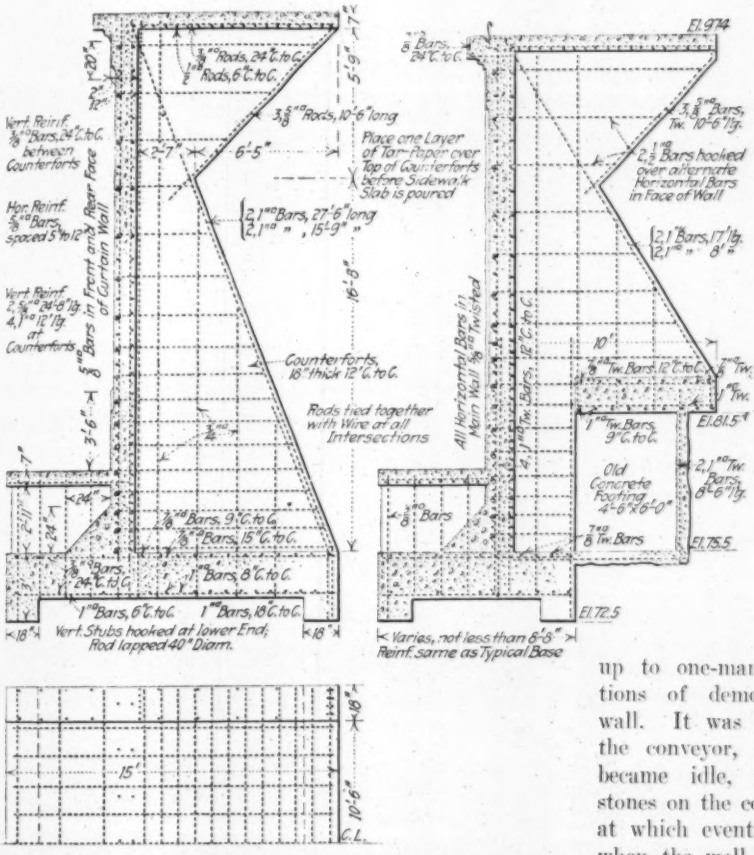

Vert. Reinf. ⅜" Bars, 24" c. to c. between Counterforts
Hor. Reinf. ⅝" Bars, spaced 5" to 12"
Vert. Reinf. 2, ⅝" @ 24'-6" lg. 4, 1" @ 12' lg. at Counterforts
⅝" Bars in Front and Rear Face of Curtain Wall
⅜" Rods, 24" c. to c.
⅜" Rods, 6" c. to c.
3, ⅝" Rods, 10'-6" long
Place one Layer of Tar Paper over Top of Counterforts before Sidewalk Slab is poured
2, 1" Bars, 27'-6" long
2, 1" " 15'-9" "
Counterforts, 18" thick 12' c. to c.
Rods tied together with Wire at all Intersections
⅜" Bars, 9" c. to c.
⅜" Bars, 15" c. to c.
⅜" Bars, 24" c. to c.
1" Bars, 8" c. to c.
1" Bars, 6" c. to c.
1" Bars, 18" c. to c.
Vert. Stubs hooked at lower End; Rod lapped 40" Diam.
⅝" Bars, 24" c. to c.
All Horizontal Bars in Main Wall ⅝" Twisted
4, 1" Tw. Bars, 12" c. to c.
El. 97.4
3, ⅝" Bars, Tw. 10'-6" lg.
2, 1⅛" Bars hooked over alternate Horizontal Bars in Face of Wall
2, 1" Bars, 17' lg.
2, 1" " 8" "
⅝" Tw. Bars, 12" c. to c.
⅝" Tw.
1" Tw.
El. 81.5
1" Tw. Bars, 9" c. to c.
Old Concrete Footing 4'-6" x 6'-0"
2, 1" Tw. Bars, 8'-6" lg.
⅝" Bars
7, ⅝" Tw. Bars
El. 75.5
El. 72.5
Varies, not less than 8'-8"
Reinf. same as Typical Base
15'
10'-6"
C.L.

FIG. 1. TYPICAL DESIGN (AT LEFT) AND (AT RIGHT) DESIGN MODIFIED TO AVOID OLD FOOTING

latter had hardened. The bottom of the forms was shimmed to exact level. The forms were made in four horizontal sections, each about 6 ft. in height. They were bolted together, with pipe spacers extending through the concrete, pipe sleeves being used as protection for the bolts and as spacers for holding the forms. The sleeves were left in the finished concrete, the bolts being withdrawn. Where the bolts extended through the face of the wall, a cast-iron building washer was used at the face end of the sleeve. This washer, 3 in. in diameter by 1½ in. thick, was removed with the form, and the hole which it left was filled with mortar of the same consistency as used in the wall. This method left no wires on the surface to rust; but the patched holes gave an unsightly appearance, which, however, improved as the mortar cured. Artificial treatment was used to make the texture of the mortar harmonize with the surrounding concrete.

Sheet metal was placed on the front face of the panel forms. The idea was to change the texture of the face, to accentuate the panel. This procedure was a success where the material adjacent to the metal was not too coarse.

The concreting plant is located near the street, about 200 ft. back from the wall; the concrete is transported to the forms in buggies. Sometimes the concrete is dumped vertically into the forms. At other points it is chuted. The concrete is thoroughly tamped in place by means of long poles. From 48 to 72 lin.ft. of wall to its full height is poured at a run. An insert to take the outer walk is left in the vertical wall, as shown in Fig. 1. The reinforcing steel is placed as the forms for each section are added.

Thirty days are allowed for setting, then backfilling is begun, using the dirt of the coffer-dam in the river. The lower walk is poured before the removal of the coffer-dam. In this walk there is an expansion joint every 24 ft., and the reinforcement steel of the walk is carried into the wall at every other counterfort. The same condition prevails in the case of the upper walk. For the outer walk the concrete is wheeled from the mixer and chuted from the top of the wall. For the upper walk the concrete is wheeled to the site in buggies and dumped and spread.

The muck was lifted to the wall by a home-made ladder conveyor (described in *Engineering News* of Dec. 9, 1915). The coffer-dam contained, in addition to muck, a certain amount of stone, up to one-man size, which had formed the foundations of demolished buildings on the site of the wall. It was impossible to handle these stones with the conveyor, so when any of the contractor's men became idle, they were set to work piling these stones on the completed foundation slabs between points at which eventually would be the counterforts. Thus when the wall had risen to its full height, the stones were located on the land side and did not have to be disturbed. The earth-fill, handled by the conveyor, covered them. The rocks had been moved a few feet horizontally with less effort than would have been required had they been left until the wall was completed and then lifted 23 ft. and dropped or piled behind the wall.

Double stairways are placed in the face of the wall midway between bridges, to give access from the lower walk to the upper walk (10 ft. wide). This location was adopted because it was believed that travel would be deflected along the wall in front of the stores and thereby add to the value of the river frontage. Fig. 4 shows how new building footings are constructed as part of the wall. This detail will save property owners from going to the expense and inconvenience of sinking piers to good bearing through the filled material, when they wish to erect buildings fronting the river. A balustrade with an ornamental and easily constructed concrete spindle was adopted after careful consideration. This type of balustrade does not provide for surplus drainage of

FIG. 2. CHUTING FOUNDATION CONCRETE OFF FIRST ST. BRIDGE; WALL FORMS IN FOREGROUND

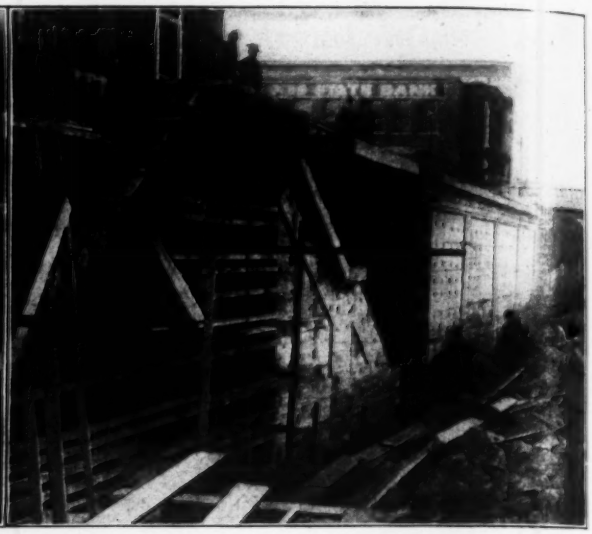


FIG. 3. FORMS IN PLACE FOR CONCRETING STAIRWAY; SECOND ST. BRIDGE IN DISTANCE

the upper walk, on account of the continuous lower chord of the rail. Drainage was provided by placing cast-iron boxes in the lower chord and making connections between them and the ground drain at every other counterfort, or in every bay. The spindles, which are unusually well made, were cast in Cedar Rapids.

River-improvement work had been contemplated in Cedar Rapids for a number of years. The first commission was appointed by the governor in 1902. Its initial work was the location of the meander lines. The first funds were obtained in 1905, by the sale of lands to the Chicago & Northwestern Railway Co. After running the meander lines the problem was to determine the necessary channel width.

The river wall is being built partly by funds provided through special assessment of abutting property and partly through general taxation, being paid from the taxes levied to support the work of the River Front Improvement Commission of Cedar Rapids, whose members are T. H. Simmons, chairman; E. E. Richards and T. R. Warriner. The original engineering design was worked out by Howard R. Greene, of Cedar Rapids. M. L. Fox was in charge of the engineering in the field. The contractor is Frank K. Hahn, of Cedar Rapids.

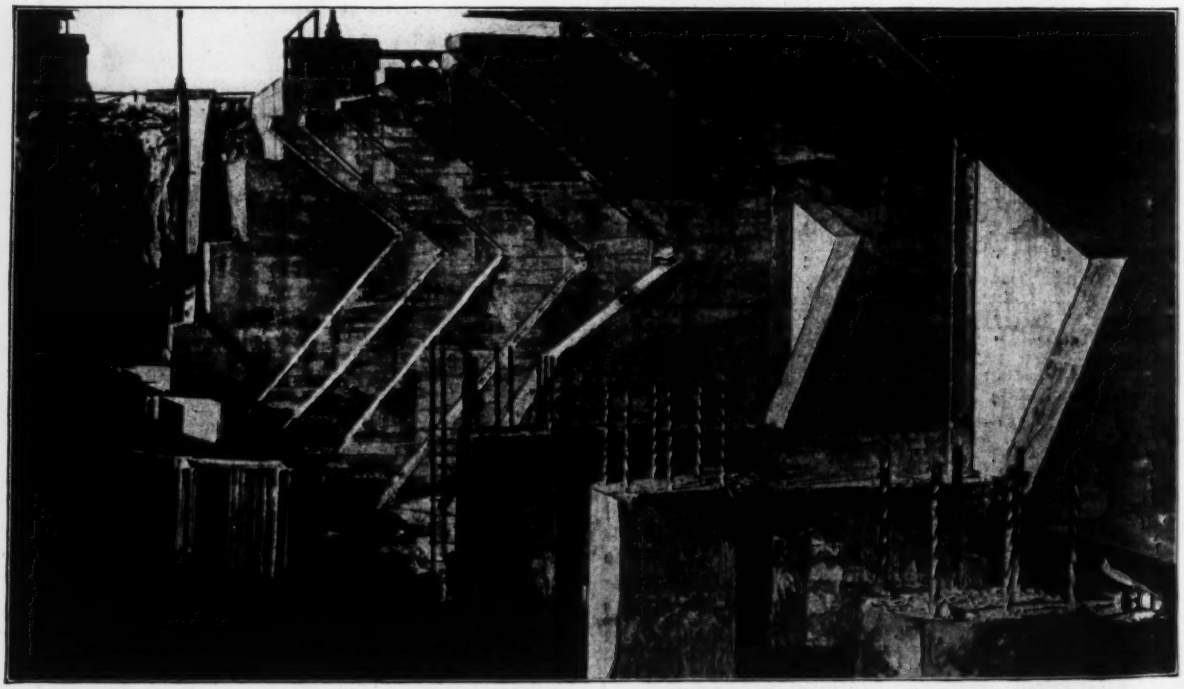


FIG. 4. REAR OF SECTION OF WALL BUILT ACCORDING TO MODIFIED DESIGN SHOWN IN FIG. 1

Footings in the foreground are incorporated in wall foundation, and are intended to help support future buildings fronting the walk on top of wall

Layout of Street Intersections on Steep Grades

The establishment of grades at street intersections is often a difficult matter in a hilly city, such as Duluth, Minn. The methods there employed were described by John Wilson, civil and sanitary engineer, in a paper read at the annual meeting of the Minnesota Surveyors and Engineers Society, Feb. 12. The methods are slightly modified from those proposed some years ago by Andrew Rosewater and Rudolph Hering, employed by the city as consulting engineers.

If the grade is 2% or less (Rosewater and Hering allowed 3%), it is carried across the intersection without breaking. If the grade exceeds 2%, but is not more than 8%, it is broken at the curb line and carried across the intersection on a 2% grade. If the grade exceeds 8%, it is broken at both the curb and property lines. In the business section the grade between the curb and the property line is limited to 5%, in order to avoid the transverse slope of one sidewalk being toward the building or that of the other exceeding 10%.

In the business district the elevation of the sidewalk at the building corner is determined by adding 2% of the distance between the curb and the building line to the elevation of the curb opposite and then taking the mean between these two elevations, provided the elevation thus determined is not less than that of the higher curb. In the residence district there is no advantage in establishing the grade of the property corner.

As the elevation of the center of the street will depend upon the crown of the pavement selected, this elevation should be used only in determining the elevations of the curbs and should not appear on the established grade, unless the center-line profile only is established. In the latter case the curb grades must be made to conform with the center grade and the character of the improvement. However, as sidewalks are usually the first improvement on a street and the property owners improve their front to conform with the walk, the first method is preferable, notwithstanding the uncertainty in assuming a width of pavement.

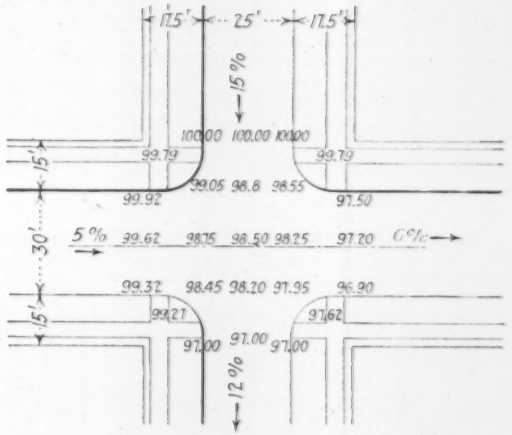
The method of establishing the curb and sidewalk grades in the residence district is best explained by a typical case. Assume that the intersecting streets are both 60 ft. wide and that the distance between the curbs is 25 ft. on the steeper street and 30 ft. on the other. This leaves 17½ ft. between the curb and the property line in the first case and 15 ft. in the second case, as shown on the accompanying plan.

The grades on each side of the street intersection of the street having the steeper grade exceed 8% and are therefore broken at both the property line and the curb line. The grades on the other street, being less than 8%, but more than 2%, are broken at the curb line only. The center-line grades of both streets are now computed. As the street having the steeper grade is practically at right angles to the contours, it will be an advantage to fix the elevations of the curbs on the two sides of the street at the same height. On the other street the cost of construction can be decreased and the improvement made to conform more nearly to the adjoining property by making one curb higher than the other.

The elevation of the curb on the steeper street is taken from the elevation of the center of the street opposite, while the elevation of the intersection of the property line extended and the curb on the other street is determined from the elevation of the intersection of the curb extended with the center line of the first street. This gives a fall of 2% across the hillside street, or the street parallel with the contours.

If the pavement selected on the latter street has but little crown or is of a slippery character, the curb on the upper side of the street is made 10 in. and the curb on the lower side 6 in. high. The crown of the street may also be placed at the third point instead of in the center. The elevation of the intersection of the outer edge of the sidewalk is made higher than the elevation of the higher curb by an amount equal to 2% of the width of the grass space, and the discrepancy with the lower curb is taken up in the grass plot.

In some cases on the lower side of the street the sidewalk is placed below the curb. This should not be more



PLAN OF INTERSECTION OF STREETS HAVING STEEP GRADES

than 8% of the width of the grass plot, in order to avoid the appearance of a sag in the walk. Where the transverse slope of the walk at the intersection will be excessive by this method, the walk grade is broken at a point 25 ft. from the curb and is made to meet a mean elevation, as in the case of a business district, except that the elevation of the walk may be less than that of one of the curbs.

Tests of an Escalator of the Cleat Type, in use at the Washington St. station of the Boston subway, are described in the report of the Boston Transit Commission for 1915. There are two escalators at this station, one for each platform. The escalator leading to Chauncy St. has a vertical lift of about 34 ft. and was subjected to a full-load test by carrying passengers averaging 140 lb. each at the rate of 7,200 per hr. for three consecutive hours. The escalator is located close beside one of the station stairways, and the men employed to make the test rode up on the escalator and walked down the stairways. With 336 men it was possible to keep the escalator continuously loaded with approximately its full specified load. The total load lifted by the escalator during the test was 20,112 men, averaging 153.9 lb. This work was done in three hours, or at the rate of 1,031,745 lb. per hr. This exceeded the contract requirement by about 2.35%. In a maximum of 20 min. of service the escalator hoisted passengers at the rate of 7,782 per hr., or 1,197,650 lb. per hr., exceeding the contract requirement by about 18.8%. The efficiency of the escalator, or the ratio between the horsepower actually required to lift the men and the horsepower received over the feed wires of the control apparatus, was found to be 72%, or 10% in excess of the contract guarantee. The contract price of both escalators, which were furnished by the Otis Elevator Co., was $25,725.

Building 22 Mi. of Pipe Sewers Under One Contract

SYNOPSIS—Close preliminary estimates required many test borings. Trenching machines used throughout, sometimes in narrow alleys. Careful personal supervision by contractor. Cost data given.

In Topeka, Kan., there is under construction at present 22 mi. of vitrified-pipe sanitary sewers. The work is all under one contract, which was let Aug. 10, 1915, and will be completed by June 1, 1916. The district in which these sewers are being built is known as the East Side and contains 7,000 city lots, each approximately 20x150 ft. in size. The soil of practically this whole section is a sticky black gumbo, with some stretches of sandy loam. There is only 198 cu.yd. of rock excavation in the estimate of the entire 22 mi. The sewer system was planned and is being constructed under the supervision of A. R. Young, city engineer. The contractor is James A. Pringle, of Topeka. The estimated cost of the work, including engineering expenses, is about $130,000.

Preliminary Investigations and Design

Money for sewer construction in Topeka is obtained by assessments for benefits; but the property owners are allowed a term of years in which to make the payments, so that the actual construction costs are met by a bond issue the amount of which must be based on accurate estimates. Hence, in addition to the usual surveys test borings were made every 100 ft. throughout the length of the proposed sewers. Where indications of rock occurred, the borings were made every 25 ft.; and in rock, every 5 ft.

This work required the services of 7 men at $2 a day for 20 days, a total of $280, but it eliminated all gamble on the amount of rock excavation. In work so far done, rock has never been encountered at depths varying more than 2 in. from the depths shown by the test borings. Mr. Young believes that similar systematic borings should be made a part of all sewer surveys and recommends that the borings be made by core drills. On this work, hand augers were used.

The design of these sewers was based on the assumption of three people to a lot (21,000 people in all), an average water consumption of 100 gal. per capita per day, with a maximum consumption of three times this. No laterals are less than 8 in., and the mains are designed to take the maximum flow of the laterals plus an allowance of 20% for infiltration, leakage at manhole heads, etc. The pipe used varies from 8 to 45 in. in diameter. The following are the minimum grades: For 8-in., 0.32%; 10-in., 0.24%; 21-in., 0.16%; 45-in. (which is a combined sewer), 0.1%. The intermediate sizes, 15- and 18-in., have minimum grades of 0.16%. In the 22 mi. are 98 flush tanks of the Miller automatic siphon type and 248 manholes.

The minimum depth of cover is about 8 ft., or 9 ft. below the tops of the house basements. The depths run from 8 to 25 ft. The total amount of excavation is about 96,000 cu.yd. The greatest part of the work is in alleys, for Topeka, like many other Middle Western cities, is laid out with an alley (12 to 20 ft. wide) in the middle of each block, lengthwise of the blocks. The householders generally begin sanitary improvements by connecting their outhouses or privies to the sewer, so that there is a considerable popular demand for alley sewers. There is a saving to the city, for there is less interruption to street traffic and many cuts in pavements are prevented. The streets are generally well paved, while the alleys are not. Water and gas mains are laid in the streets, though this often requires destroying a pavement.

The use of the alleys for sewers makes it possible for

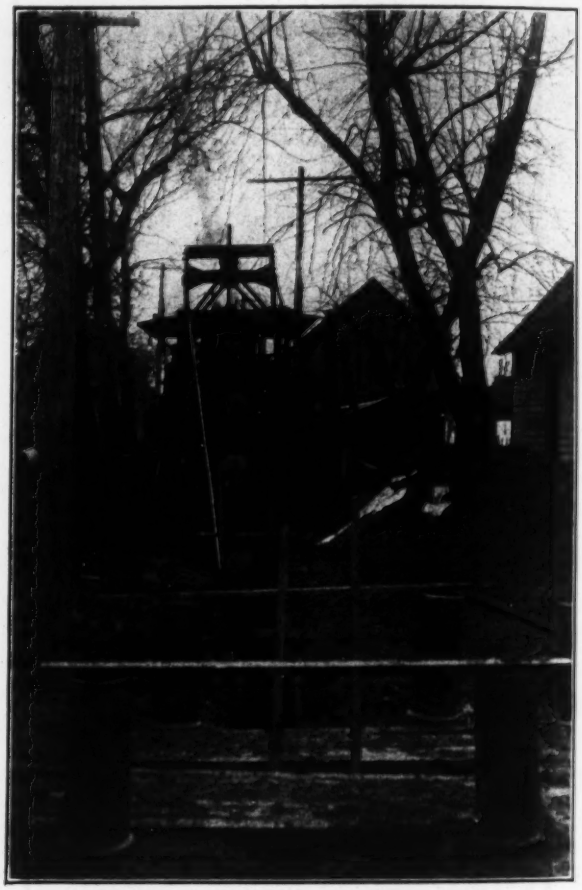


FIG. 1. TRENCHING MACHINE WORKING IN A 14-FT. ALLEY, TOPEKA, KAN.

the contractor to do almost all the excavation by machine, for there is no interference with other underground structures except at street intersections. Before a street having water and gas mains is crossed, these pipes are accurately located by the contractor, and the trenching machine is so operated as to avoid them. Where it can be conveniently done, the gas mains are uncovered, a length of pipe taken out and the trenching machine run past, which can be done without shutting off the gas for more than half an hour. Street-car tracks are crossed in the same manner. The contractor, Mr. Pringle, states that he has encountered no difficulties with the public-service corporations in carrying on this work.

FIG. 2. ALLEY THROUGH WHICH A TRENCHING MACHINE HAS OPERATED; MANY BUILDINGS HAD TO BE MOVED

The contractor is doing the work very expeditiously with two Austin trenching machines and two backfilling machines of the same manufacture. One trenching machine digs a trench 3½ ft. wide up to 16 ft. in depth, and the other a trench 4½ ft. wide up to 25 ft. deep. The average day's run with each machine varies from 200 to 500 ft. of trench. The best record was 1,050 ft. in a working day of 9 hr. Some difficulty is experienced in going through narrow alleys. These are public highways and their legal width is 20 ft., but there are many encroachments by barns, sheds and other outhouses, so that the actual clearance in some instances is not more than 12 ft. The trenching machine requires a clearance of 14 ft. to do its work. Consequently, the contractor is often required to move buildings, telephone poles and other obstructions—and move them back again.

This, Mr. Pringle assured the writer, was not difficult to accomplish, as he moved the buildings first and in case of dispute settled with the owner afterward. But by handling the work diplomatically he has had no serious disputes or difficulties. His total bill for damages does not exceed $100. He has forbidden his workmen to have any words with property owners and attends personally to all such cases. It is hardly believable that a trenching machine could get through some of the alleys, such, for instance, as are shown in Figs. 1 and 2.

The contractor's methods of operation are as follows: There is a foreman who directs the course of the machine and the pipe laying; one man precedes the machine and levels the ground for its movement; one man operates the machine, doing his own firing; the foreman already mentioned sets the batters; one man in the trench follows the

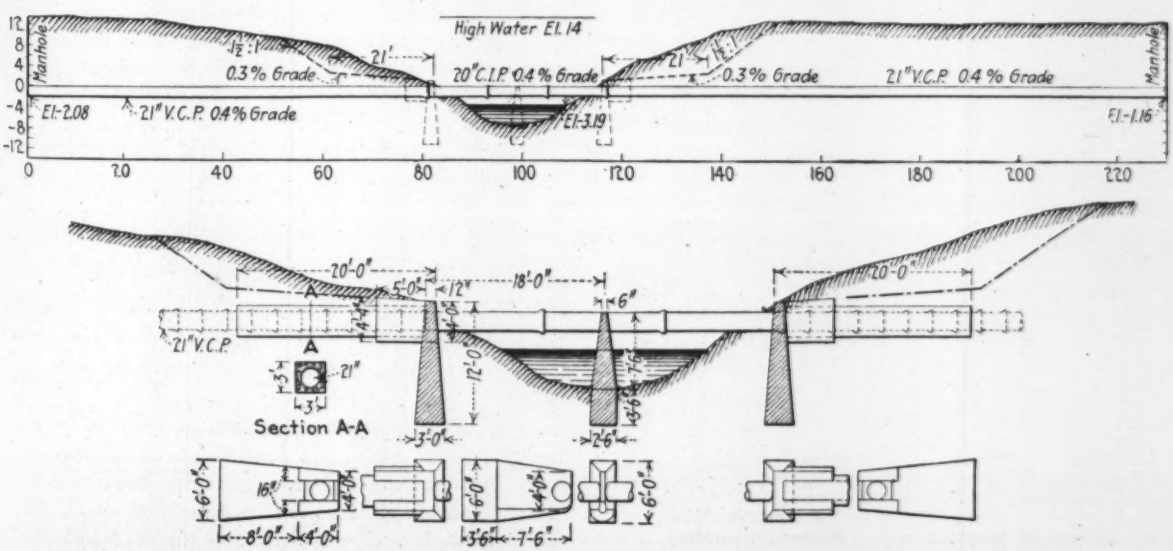


FIG. 3. PROFILE ELEVATION AND PLAN OF CREEK CROSSING OF 20-IN. SEWER AT TOPEKA, KAN.

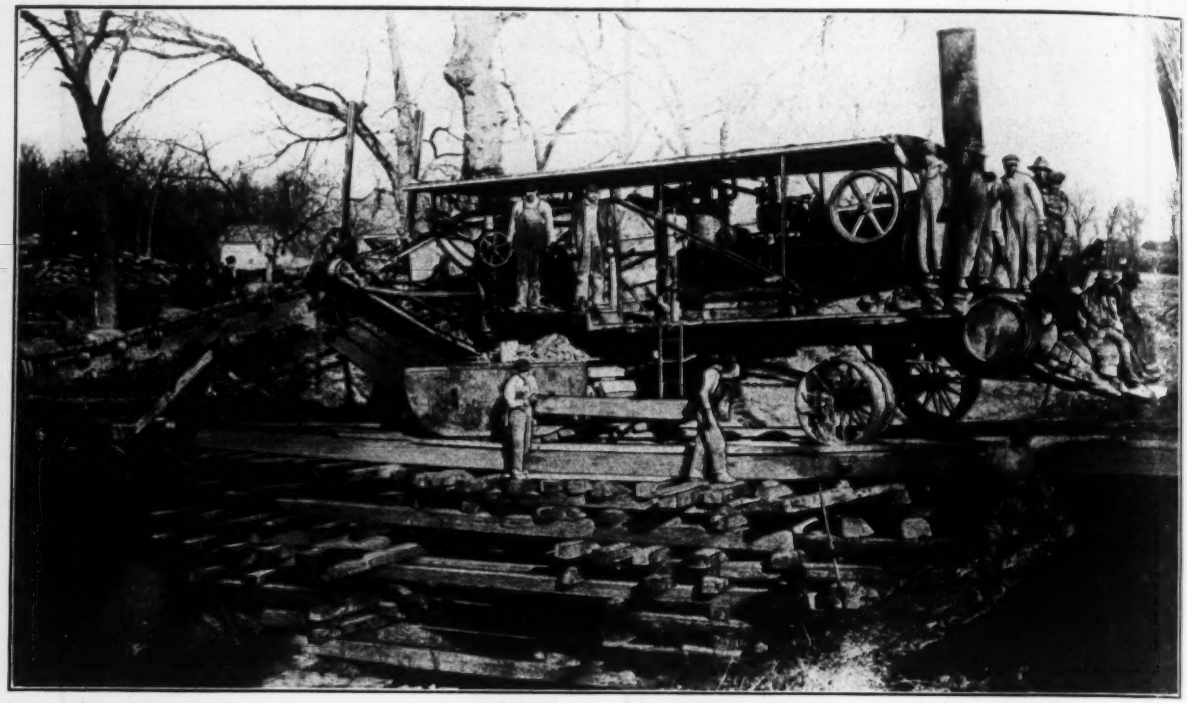


FIG. 4. TRENCHING MACHINE CROSSING CREEK, TOPEKA, KAN.

machine, cleaning up the trench by shoveling the loose material into the buckets and putting in the lower jacks and braces; one man above works with the one in the trench, setting the upper braces; two pipe layers work in the trench and two on the surface (a tripod is used for lowering the pipe); two men follow the pipe layers, taking out the jacks and braces and tamping earth around the pipes. Then come the backfilling machine and a clean-up gang, the size of which depends on the work to be done.

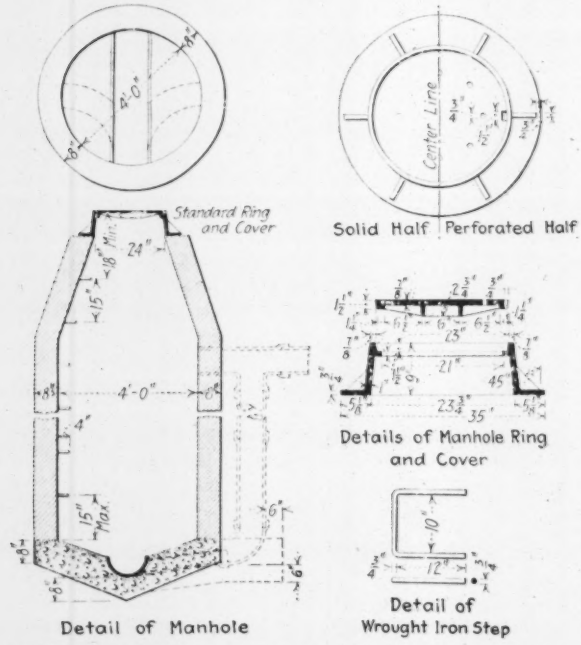


FIG. 5. DETAIL OF SEWER MANHOLES, TOPEKA, KAN.

The average force with each trenching machine is 25 men, and the excavation alone can be done as cheaply as 8 or 10c. per cu.yd. The backfilling costs more. The contractor acts as his own general superintendent. The foremen receive $35 a week and the machine operators $25. It has been found that the pace of the whole outfit is set by the trench speed of the pipe laying, because the specifications do not allow more than 300 ft. of open trench, so the contractor pays the men engaged in pipe laying a bonus of 1c. per section of pipe laid over a certain weekly minimum. While this practice often means an actual loss in this item, the work as a whole is much expedited.

An instrumentman is continually on the work, and every length of pipe is set by an engineer's level. There is no complicated system of batter boards—a single cord for alignment is all that is required. This method has worked out so satisfactorily that it is recommended by Mr. Young even where the contractor has to employ his own instrumentman.

In backfilling, the earth is placed in layers of not over 9-in. thickness until there is a cover of not less than 2 ft. over the top of the pipe. This material is thoroughly rammed. About this level the backfilling is consolidated by puddling. In the narrower alleys the backfilling machine cannot be operated efficiently. At least 6 ft. of space on one side of the trench is necessary. Usually the backfilling is completed not over 150 ft. behind the trenching machine, and the distance is never more than 300 ft.

A very ingenious device has been provided to keep the trench free of water. It consists of an ejector pump made by extending a 1-in. steam pipe down the boom of the trenching machine to a coupling with a 3-in. steam jet. The suction pipe is 3 in. and the discharge pipe 2 in. Whenever the water accumulates in the bottom of the

trench, the machine is stopped for a few minutes and the steam jet operated.

Another item in the routine, which has much to do with the systematic progress of the work, is the proper distribution of the pipe ahead of the trenching. To accomplish this, the contractor takes a blueprint plat of the sewer and marks in red pencil at the places where they are to be delivered the number of sections of pipe, Y's, etc., to be left there. The hauling of the pipe is done by a local teamster for 40c. per ton, the average haul being about one mile.

Details of Design and Cost Data

Some of the most interesting details of the design are shown in Figs. 3, 5 and 6. The creek crossing shown in Figs. 3 and 4 is of 20-in. cast-iron pipe on concrete piers. The crossing is at the grade of the sewer. Fig. 4 shows

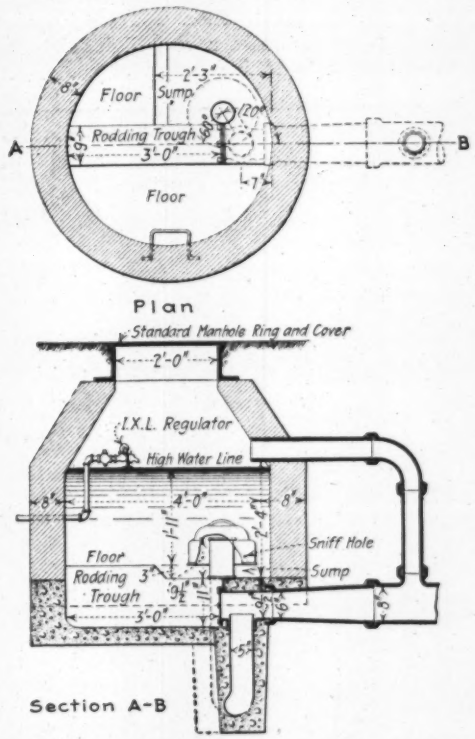


FIG. 6. DETAIL OF AUTOMATIC FLUSH TANKS, TOPEKA SEWERAGE

the trestle built to take the trenching machine over the creek at this point. There was no highway bridge strong enough to carry the machine, so the contractor built his bridge on the line of the sewer, working with it into both banks. Figs. 5 and 6 show the details of the automatic flush tanks and of the manholes. Manholes of concrete of the same design have proved very satisfactory in other parts of the city.

The accompanying tabulation shows the city engineer's estimate and the successful contractor's bids.

ESTIMATES AND SUCCESSFUL BIDS ON TOPEKA SEWER WORK

Item	Estimate		J. A. Pringle	
62,770 ft., 8-in. V. C. Pipe	$0.65	$40,800.50	$0.60	$37,662.00
22,543 ft., 10-in. V. C. pipe	.76	17,132.68	.75	16,907.25
10,966 ft., 12-in. V. C. pipe	.95	10,417.70	.87	9,540.42
4,682 ft., 15-in. V. C. pipe	1.52	7,116.64	1.46	6,835.72
3,988 ft., 18-in. V. C. pipe	1.67	6,659.96	2.00	6,976.00
2,947 ft., 21-in. V. C. pipe	2.44	7,190.68	2.46	7,249.62
2,992 ft., 24-in. V. C. pipe	3.96	11,848.32	3.90	11,668.80
281 ft., 27-in. V. C. pipe	5.50	1,545.50	4.68	1,315.08
36 ft., 20-in. c.-i. pipe	5.00	180.00	5.00	180.00
33,100 ft., 1-in. galvanized pipe	.20	6,620.00	.20	6,620.00
98 flush tanks	65.00	6,370.00	65.00	6,370.00
248 manholes	45.00	11,160.00	45.00	11,160.00
200 cu.yd. concrete	7.00	1,400.00	8.00	1,600.00
25 M. b.m. sheeting	30.00	750.00	30.00	750.00
Extra excavation	50.00	.....	.50	.....
Total		$129,191.98		$125,834.89

Owing to the fact that the assessments cover all costs 4% of the contract price is withheld from the contractor to pay the engineering costs. The contractor is permitted to make house connections for property owners at a stipulated price.

Reversing Currents Prevent Underground Electrolysis

Corrosion of pipes and other buried structures by stray currents is practically negligible when the current reverses once a minute or more often. This conclusion was drawn from a series of studies by the United States Bureau of Standards into the effect of alternating currents on soil electrolysis. The results of the investigation were presented by Burton McCollum and G. H. Ahlborn on Mar. 10, before the American Institute of Electrical Engineers, New York City, in a paper entitled "Influence of Frequency of Alternating or Reversed Current on Electrolytic Corrosion."

The finding is of importance, for the use of the insulated negative-feeder system of reducing stray currents usually brings an extended "neutral zone" where the potentials of pipes, etc., to ground are small and reversing. In the case of iron no appreciable corrosion was found with alternating currents of between 15 and 60 cycles per second, but no such limit was found for lead. The addition of sodium carbonate to soil reduces the corrosion of iron and increases that of lead. Corrosion of iron reaches its maximum value when the current-reversal cycle occupies more than two weeks; with lead the maximum corrosion is reached with a frequency of reversal between one day and one week.

These phenomena are explained by the fact that the corrosion actions are largely reversible—the metal dissolved during one-half cycle being redeposited on the reversal. This metal may have little value mechanically, but serves as the anode surface and protects the main material from attack.

At the same meeting (held jointly with the New York Section of the American Electrochemical Society) Prof. W. H. Walker, Massachusetts Institute of Technology, presented a paper dealing with the corrosion of metals more generally. Of interest in connection with the preceding paper was Professor Walker's statement that the freedom of copper-steel from corrosion (weathering) is due to the formation of a protecting layer of oxide. Dr. A. S. Cushman, Washington, D. C., in discussion referred to experience with over 300 test pieces of copper-steel weathering in Arizona. He claimed that these showed that the copper had nothing whatever to do with the results, which depended on the nitrogen content of the metal.

A Road-Traffic Census is to be made in St. Louis County, Missouri, before deciding what type of road improvement to carry out with the bond issue voted a few weeks ago. The County Court has arranged with the Federal Government to have the census supervised by highway engineers from the Department of Agriculture. A consulting engineer on road improvements will be appointed by the county authorities.

Four-Span Steel-Arch Bridge at Indianapolis, Ind.

SYNOPSIS—This bridge has spans of 192 ft., with plate-girder arch ribs supporting spandrel columns to carry the deck framing. A traveler on the deck drove falsework and set steel within its reach and then moved forward to place the next portion of falsework and steel.

A steel arch bridge with four spans of 192 ft. has been built at Indianapolis to carry West New York St. across the White River. It is on a skew of 54° 17′ with the river and has a length of 792 ft. between abutment faces. It has a 24-ft. roadway (without car tracks) and two 8-ft. cantilevered sidewalks. The live-load specifications provide as follows: For the roadway, 150 lb. per sq.ft. and a 15-ton road roller; for the sidewalks, 100 lb. per sq.ft.; for the ribs, the same as the roadway plus 5,000 lb. concentrated at points giving maximum and minimum moments. The calculations were made for the middle rib, and the three ribs were built to the same design.

The bridge was designed by Frederick H. Burnette, of Indianapolis, as consulting engineer for Paul Julian, County Surveyor. The contract was let to the Central States Bridge Co., which sublet the substructure and concrete work to the American Construction Co., both of Indianapolis. A view of the partly completed structure is shown in Fig. 1.

Each span consists of three plate-girder hingeless arch ribs, with radial stiffeners and splices. The ribs are shaped to a parabolic curve, with a rise of 21 ft. 9 in. above the springing, are spaced 12 ft. apart and are connected by transverse and diagonal lattice trusses framed between the webs. The construction is shown in Figs. 2, 3 and 4.

The ribs were calculated as having fixed ends, and their supports were made very heavy to insure this condition. At the piers the ribs are riveted to plate-girder skewbacks on steel bents, or towers, that are anchored to the foundation concrete and afterward embedded in the concrete of the upper part of the piers. The skewbacks have projecting cover plates that lap over the chords of the ribs, as shown. At the abutments the ends of the ribs are riveted to heavy steel anchorages. The expense of this construction was considered well warranted, in order to obtain a very high safety factor at these critical points in the design of the structure.

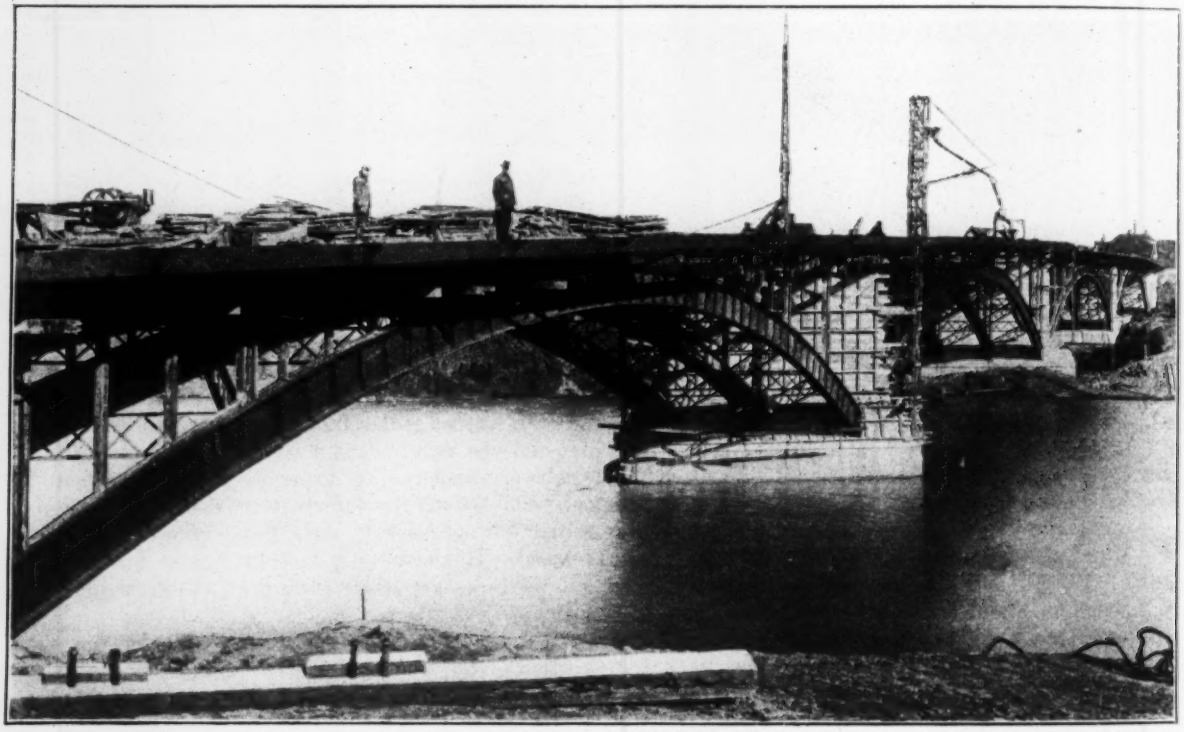


FIG. 1. STEEL ARCH BRIDGE OVER THE WHITE RIVER AT WEST NEW YORK ST., INDIANAPOLIS, IND.

Upon the ribs are spandrel columns (8-in. H-beams) supporting three longitudinal lines of 20-in. I-beams, between which are framed 12-in. tranverse I-beams 5 ft. apart. Each sidewalk is supported by 8-ft. cantilever brackets 19 ft. 2 in. apart, carrying an outer line of 12-in. channels. Between pairs of cantilevers are two intermediate supports consisting of 6-in. I-beams framed against the outer channel and resting on top of the 20-in. longitudinal I-beams.

This floor framing, which is shown in Fig. 4, is all incased in concrete and supports a reinforced-concrete slab. The sidewalk slabs are finished to form the wearing surface, while the roadway slab is covered with asphalt paving.

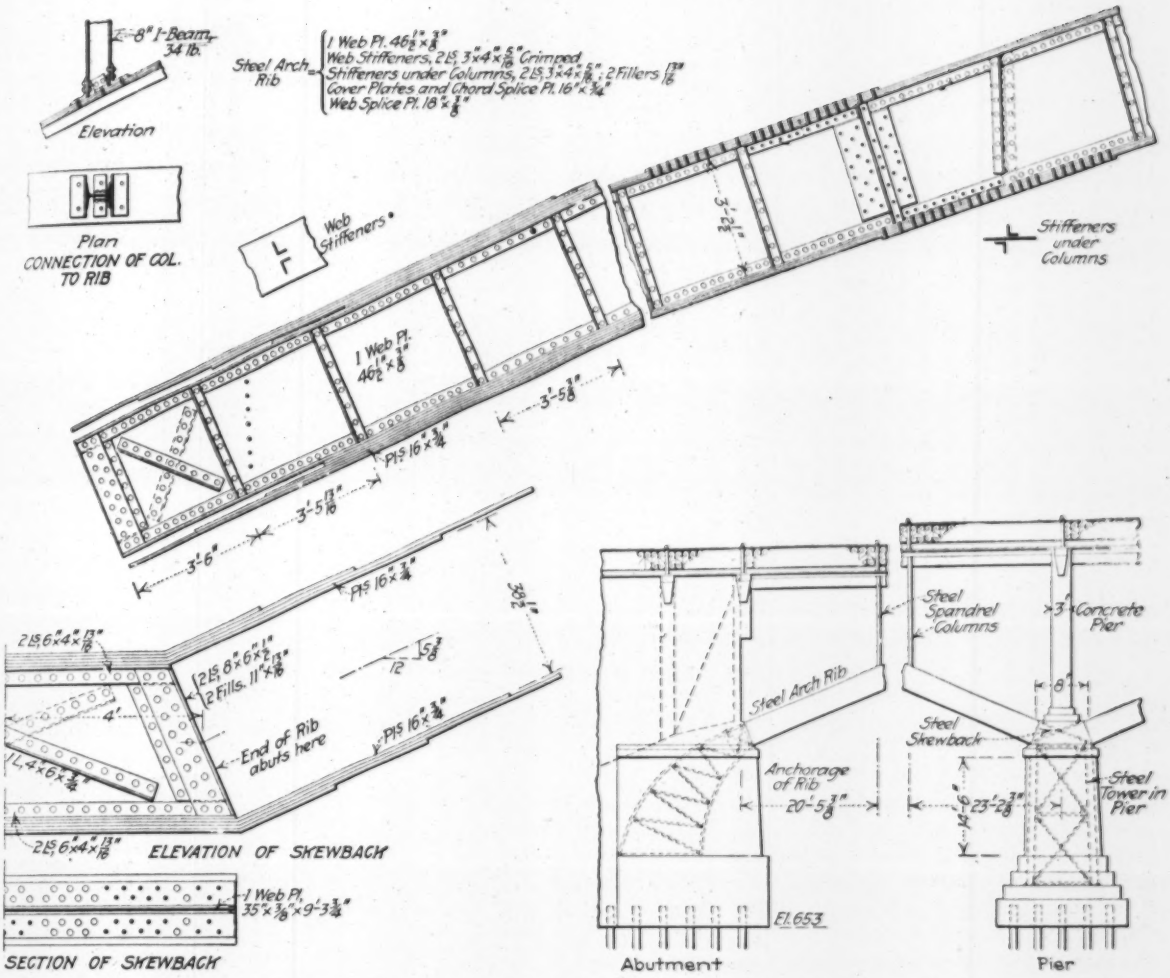


FIG. 2. STEEL ARCH RIBS AND SKEWBACK GIRDERS ON PIER

FIG. 3. ANCHORAGES AND TOWERS IN ABUTMENTS AND PIERS

The piers and abutments are of concrete, with pile foundations. The steel arch ribs are not supported directly by the concrete, but by the steel anchorages in the abutments and the steel towers in the piers, as already explained. The concrete of the main body of the piers and abutments was placed after the erection of the steel. Pockets were left for the projecting parts of the steel skewbacks and anchorages, and these pockets were filled with concrete when the steel ribs had been placed and riveted.

After the erection of the steel a 30-in. wall was carried up above the top of the pier proper to the level of the deck. The abutments are carried up in the same way. They have straight vertical wing walls, with coun-

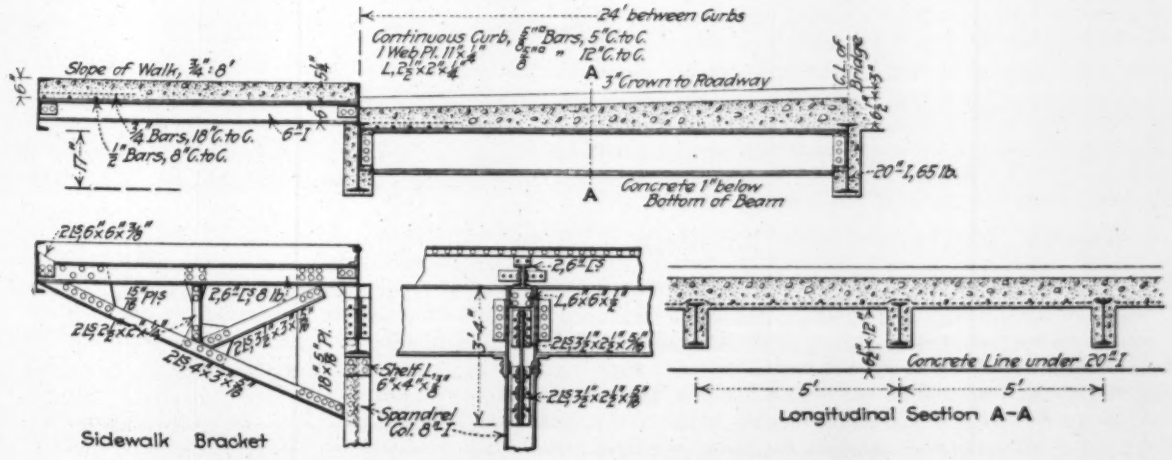


FIG. 4. FLOOR FRAMING OF WEST NEW YORK ST. BRIDGE AT INDIANAPOLIS, IND.

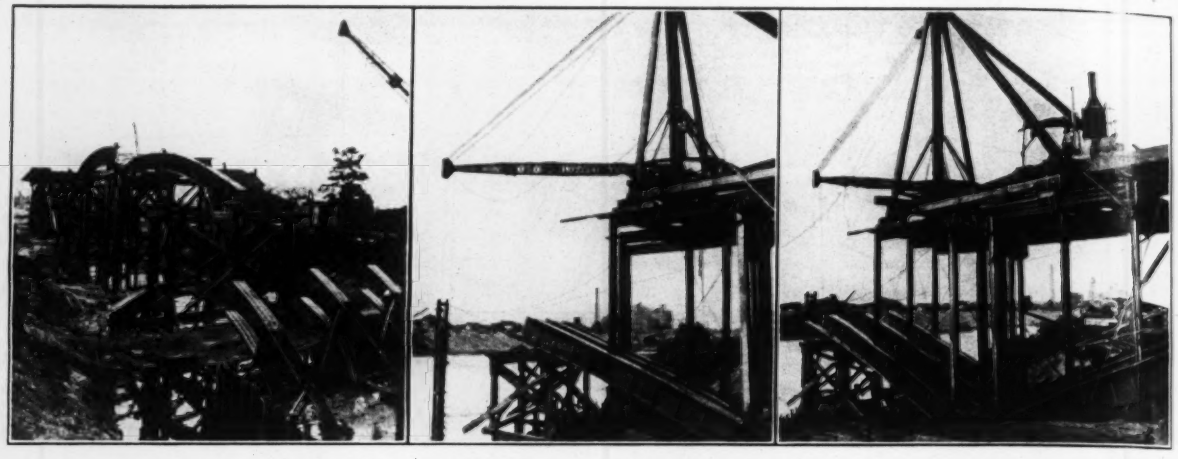


FIG. 5. CONSTRUCTION WORK ON THE STEEL ARCH BRIDGE AT INDIANAPOLIS

terforts on the inner side corresponding to the outside cantilever brackets for the sidewalk approaches.

The erection of the steel superstructure was commenced July 1 and completed (except for the hand railing) on Nov. 1, 1915. The two shore spans at the east end were erected by a traveler working parallel to, and on the north side of, the bridge. The ground on which this traveler moved was about 8 to 10 ft. above the springing line of the arches. Fig. 5 shows some of the stages of the construction work.

The traveler was placed upon the deck of the structure by means of the storage-yard derrick, located just north of the pier between the two shore spans. It then moved westward, driving piles for falsework by means of a steam hammer in leads slung from the boom. When all the falsework bents within reach were completed, the steel was erected upon them; and the traveler moved forward to drive piling and place steel for another section of the arch. For each span there were eight three-post bents, braced together in pairs to form four towers.

The traveler was an A-frame derrick of steel construction, moving on rollers and having a platform about 30x18 ft. The mast was 40 ft. high, and the box lattice boom was 75 ft. long. The machine complete weighed about 15 tons and was operated by a steam hoisting engine. The lifting capacity was 15 tons, and the heaviest loads handled weighed about 12 tons. This traveler was arranged to occupy about half the width of the floor, and on the other half was a material track for moving out the steel, which was loaded on push-cars by the derrick at the storage yard (along the north side of the two east spans).

The total weight of structural steel is about 830 tons. The exposed steel is given one finishing coat of black paint.

Heavy Rails on the Lehigh Valley Railroad

The new 136-lb. rail of the Lehigh Valley R.R. is the heaviest yet adopted in this country. The Central Railroad of New Jersey has had a 135-lb. rail for some time, and the Pennsylvania R.R. last year adopted a 125-lb. rail, as noted in *Engineering News*, Oct. 14, 1915.

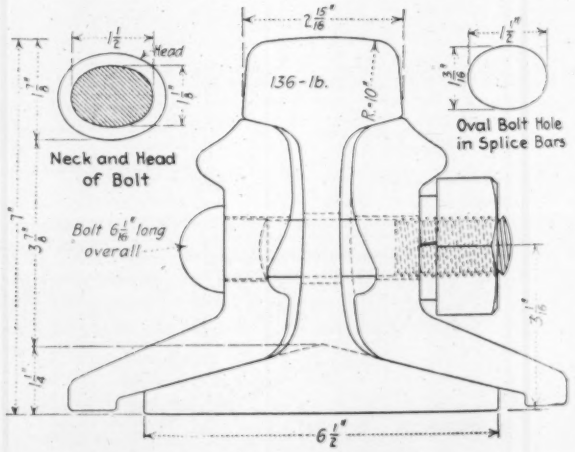
This new rail is designed especially for use on the mountain divisions having heavy grades and sharp curves. There is very little of it in service as yet. Its dimensions are given in Table 1. This road already had a 110-lb. rail for use under such conditions, where the wear of the rail head is exceptionally severe (*Engineering News*, Oct. 24, 1912). The new 136-lb. rail has the unusual height of 7 in. The older 110-lb. special section is of the same height as the standard 100-lb. section (6 in.), the

TABLE 1. DIMENSIONS OF HEAVY RAILS; LEHIGH VALLEY R.R.

	136 lb.	110 lb.
Weight per yd.		
Height	7 in.	6 in.
Width of base	6½ in.	5½ in.
Width of head, bottom	2 11/16 in.	2⅜ in.
Side of head, slope	4°	
Depth of head	1⅞ in.	1⅞ in.
Depth of web	3¾ in.	3 1/16 in.
Depth of base	1½ in.	1⅛ in.
Thickness of web	7/16 in.	⅜ in.
Thickness, edge of base	11/16 in.	½ in.
Height to center of hole (and neutral axis)	3 11/16 in.	2¾ in.
Radius of:		
Head	10 in.	10 in.
Top corners of head	1/16 in.	1/16 in.
Bottom corners of head	½ in.	½ in.
Sides of web	14 in.	14 in.
Top fillets	½ in.	½ in.
Bottom fillets	½ in.	½ in.
Corners of base	1/16 in.	1/16 in.
Fishing angles (4 to 1)	13°	13°

TABLE 2. PROPORTIONS OF HEAVY RAILS

Railway	Lehigh Valley R.R.	Pennsylvania R.R.	Central Railroad of New Jersey
Weight	136 lb.	125 lb.	135 lb.
Height	7 in.	6¼ in.	6¼ in.
Head	35.4%, 4.72 sq.in.	38.9%, 4.73 sq.in.	40.28%
Web	23.7%, 3.17 sq.in.	20.3%, 2.47 sq.in.	21.90%
Base	40.9%, 5.46 sq.in.	40.8%, 4.95 sq.in.	37.82½%
Total	100.0%, 13.35 sq.in.	100.0%, 12.15 sq.in.	100.00%
Moment of inertia	86.57	68.7	72.39



136-LB. RAIL; LEHIGH VALLEY R.R.

additional weight being given by a greater depth of head, which resulted in a correspondingly reduced depth of splice bar. The new rail has the same exceptional depth of head.

The distribution of area and weight in the 136-lb. rail, as compared with two other heavy rails, is given in Table 2. It will be seen that the proportion of metal in the head is lower in the heaviest rail. That is due mainly to the greater height, but the head of the 125-lb. rail is somewhat larger than that of the 136-lb. rail.

The joints of the 136-lb. rail are spliced with heavy angle bars, which are only 26 in. long, but have six bolts spaced 4 in. c. to c. The bolts are of unusual size—$1\frac{1}{16}$ in. in diameter—in the shank, and have rolled threads $1\frac{1}{8}$ in. in diameter. The neck and head are both oval, as shown. Square nuts and spring nut locks are used. As the bolts are placed alternately with head and nut on the inside of the rail, the bolt holes in the splice bars are alternately $1\frac{3}{16}$ in. in diameter and $1\frac{3}{16} \times 1\frac{1}{2}$ in. oval. The rails have bolt holes $1\frac{5}{16}$ in. in diameter.

For information we are indebted to E. B. Ashby, Chief Engineer, Lehigh Valley R.R.

Report of the Panama Canal Slide Commission

A brief summary of the report of the commission to study the Panama Canal slides, which was nominated by the National Academy of Sciences and appointed by President Wilson, Nov. 18, was printed on page 532 of the last issue. A more extended abstract of the report follows:

The total amount of material excavated and remaining to be excavated from the slides on the Panama Canal in the Gaillard Cut is in round figures about 50,000,000 cu.yd. It is of interest to mention that this is more than half as great as the yardage which was estimated by the Board of Engineers of 1906 as the total excavation required for the Panama Canal work. At that time also the total estimated excavation for the Gaillard Cut was less than 54,000,000 cu.yd., but this amount was afterward increased by enlargement of the cross-section.

The three great slides on the canal are, first, the Cucaracha slide, which has been in progress since the days when the work under De Lesseps was active in the early 80's. Nearly 10,000,000 cu.yd. had been excavated from this slide by Dec. 30, 1915. It is located immediately south of the traprock dike known as Gold Hill, the top of which is about 600 ft. above the level. North of Gold Hill is the East Culebra slide, which began on Oct. 14, 1914; and from this slide 14,687,000 cu.yd. had been excavated to Dec. 30. The third great slide is the West Culebra slide, immediately opposite the East Culebra slide, from which about 11,000,000 cu.yd. had been excavated to Dec. 30.

From all the other slides on the sides of the Gaillard Cut the total excavation was only 4,852,000 cu.yd. to Dec. 30. The total yardage remaining to be excavated in the three great slides on Dec. 30 was 9,600,000 cu.yd.; and from all other slides combined, only 330,000 cu.yd.

Answering the question whether the great slides will extend their limits and cause further serious trouble, the commission believes that no great extension of these slides is probable, because the soft rock that constitutes a very large part of the slide is quite limited in extent. The commission thinks it possible, however, that a large mass of soft rock between the West Culebra slide and Contractor's Hill may finally be set in motion. The mass involved, however, will be small compared with that of the West Culebra slide.

The most serious possibility in connection with the sliding ground at Panama is that the high hills along the deepest part of the Gaillard Cut may move toward the canal. The commission says that these hills, so far as it can determine, are composed of intrusive bodies of basalt or masses of the hard Obispo tuff. So far as can be judged, the hard rock masses which form these hills extend far into the earth and are self-supporting. Rock may slough off from them, but there is no evidence that they will collapse.

It should be understood that the great bulk of the sliding material at Panama is not earth, but weak rock. Most of this rock is of the stratified Cucaracha formation. These beds occur only in the Culebra district, but have a thickness in places of over 400 ft. The soft, slippery nature of the materials of which this rock is composed and their loose, unconsolidated condition make it very weak. Faults and joint planes in the rock are also partly responsible for the slides.

The commission finds no evidence that earthquake shocks have had any material effect in producing slides. It does believe, however, that the heavy rainfall has an important influence. The average annual rainfall in the Culebra district is about 85 in. per annum, concentrated in eight months of the year. Notwithstanding the ill-success of the French company in preventing slides by surface drainage, the commission believes that every available device should be used to keep water away from the slides.

The commission suggests that the deep cracks which form in the earth adjacent to the slides during the dry season as the ground shrinks should be systematically filled, in order that surface water may not be led into them. The commission also suggests drainage by tunnels driven underneath sliding ground in undisturbed material, but says the plan should be tried with caution. It is further proposed that a cut be made by sluicing with a hydraulic jet in the East Culebra slide, extending from the canal back to a large pond that now exists on the slide. A somewhat similar cut should be made in the West Culebra slide. Through these cuts material could be sluiced down into the canal.

To assist in determining the likelihood of future slides, the commission recommends a careful system of surveys to detect incipient movements of the ground and deep core borings on each side of the canal with a drill giving large cores. A study is recommended of underground water and related data, to show the water table for different localities in the Culebra district and the effect of water on the underground strata, and of the chemical changes which cause the so-called hot areas that have been found in the canal rock, with tests to determine the strength of the rock in which slides have occurred.

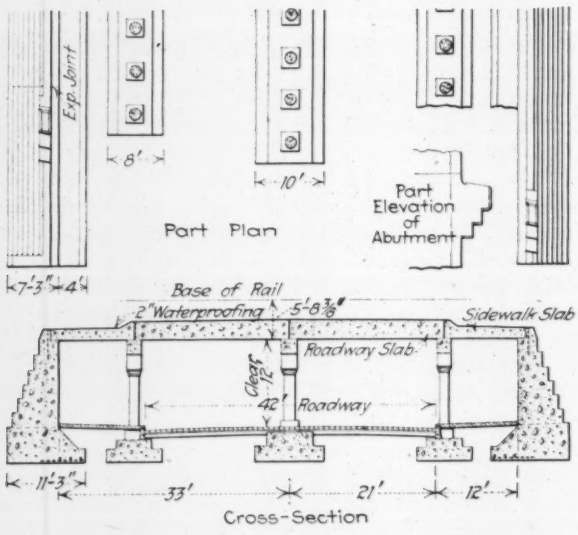
In conclusion the commission says that, while it realizes that slides may be a considerable maintenance charge upon the canal for a number of years and that possibly trouble in the Culebra district may perhaps again close the canal, it believes that, after the present slides have been removed, navigation through the canal is not likely again to be seriously interrupted.

Chicago Track-Elevation Bridges of Illinois Central R.R.

SYNOPSIS—Two types of bridges are being used on the track-elevation work of the Illinois Central R.R. at Chicago. One has concrete bents supporting concrete deck slabs. The other has steel bents and girders supporting a deck of I-beams with concrete filling, and all steelwork is incased in concrete. This article describes the design and construction methods of both types of bridges.

Track elevation on the Illinois Central R.R. at Chicago is now in progress between 78th St. and Kensington Ave. In this outlying section of the city, which is not built up continuously, the railway is not required to build a subway at every street. The ordinance specifies subways for certain streets and provides that in the future the city may require others, in which case the work is to be done by the railway, but paid for by the city.

The bridges for nearly all the subways have supporting bents at the curb lines and in the middle of the roadway. Where a sewer exists, this construction necessitates diverting it to one side of the foundations of the central bent. The type of superstructure used most extensively has bents of concrete columns and girders carrying a deck



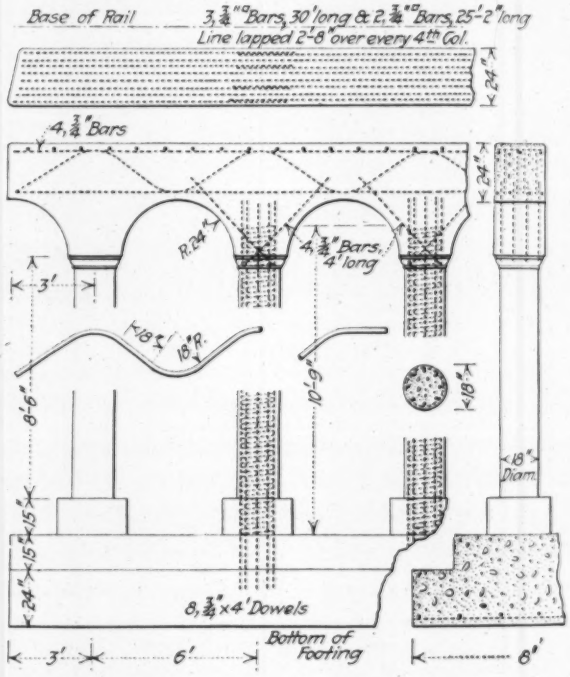


FIG. 1. CONCRETE BRIDGE ON TRACK ELEVATION; ILLINOIS CENTRAL R.R.

of concrete slabs. Where clearance conditions make it necessary to employ a floor of minimum thickness, the bents have steel columns and cross-girders carrying a deck of I-beams, with concrete filled between them. All the steel is incased with concrete or cement mortar.

Concrete Subway Bridges

The typical design of the concrete structures is shown in Fig. 1. There are three bents spaced 22 ft. 3 in. c. to c. and 10 ft. 9 in. from the faces of the abutments. Each bent has a broad footing wall built directly upon the stiff clay, no piles being used. The clearance is 12 ft. where there are no street-car lines. Upon each footing is a row of cylindrical columns spaced 6 ft. c. to c., with square bases. They are connected by arches and support a cap girder. The columns, arches and girders are of monolithic construction, and no expansion joints are provided. The middle bent has 21-in. columns and a cap girder 27 in. wide and 24 in. deep. The side bents have 18-in. columns and girders 24 in. square.

The reinforcement in each column consists of eight vertical rods and a wire spiral of 2-in. pitch, having two spacing bars to maintain the pitch while the concrete is being poured. The rods extend into the footings. The column bases have horizontal rectangular hoops. The girders have longitudinal rods in the top and bottom, with short cross-rods in the top. There are no stirrups, and none of the horizontal rods are bent up. Instead, there are wavy longitudinal shear bars, as shown. They have a depth of 18 in. and a pitch of 6 ft. for the waves, the radius of which is 18 in. In addition, there are diagonal rods extending from the columns through the knee-brace arches into the girder. All bars are of the deformed type, of square section.

The abutments are of mass concrete, with expansion joints about 25 ft. apart. The footing has a long toe extending under the sidewalk. The rough ends of the parapet slabs at each side of the bridge are masked by parapets of similar shape, built up on the bridge seats. Along the back of each abutment is a 6-in. tile drain, sloping on a grade of 1%.

The columns and girders are cast in Blaw steel forms, which are owned by the railway and furnished to the contractor. They give a smooth, dense surface finish. The wooden forms used for the remainder of the work had the tie-rods placed within tin tubes. When the forms were

removed, the rods were pulled out, the tubes clipped off and the ends of the holes filled with cement mortar.

The concrete is a 1:3:6 mixture for the footing walls, 1:2:4 for the bases of the columns and 1:1½:3 for the columns and girders. The coarse aggregate is screened limestone, not exceeding 2 in. in size for the footings. For the columns and girders the size is about ⅜ in., as the restricted space and the amount of reinforcing steel make it necessary to use a slushy mixture that will fill all voids. The only tamping that can be done is to stir the mass with long sticks of wood. In the abutments the concrete is 1:3:6 for the footing, 1:2½:5 for the main portion (faced) and 1:2:4 for the bridge seats.

The amount of concrete for the three bents is 355 cu.yd. in the footings and column bases and 115 cu.yd. in the columns and girders, or 470 cu.yd. in all. The two abutments require about 1,300 cu.yd., making a total of 1,770 cu.yd. exclusive of the deck.

The concreting of the abutments and bents was done from the contractor's train stationed on a running track given up temporarily for this purpose—usually one of the tracks on the west side. The train was made up of three cars, one being a flat-car with drum mixer.

Most of the concrete was spouted through the deck of the trestle into a hopper, from which it was discharged into wheeled carts and distributed to the forms. For some parts the concrete was spouted directly by means of a chute extending across the adjacent running track. The plan was not used extensively, as it necessitated great care and watchfulness to keep the spout clear of trains.

Concrete Slabs for Subway Deck

The decks of the concrete subways consist of rows of reinforced-concrete slabs spanning the sidewalks and the roadway. The construction of these slabs is shown in Fig. 2. The slabs for the roadway spans are 22 ft. 7⅜ in. long and 6 ft. 5¾ in. wide. Their ends are at an angle of 79° with the sides, owing to the skew of the bridge. The thickness is 34 in. for about 6½ ft. at one end (over the middle bent), and the top then has a slope for drainage to the other end, where the thickness is 31¾ in. At each end is a lifting stirrup made of a 2-in. square bar. Its loop is in a pocket that is filled with cement mortar after the slab is in place. The slabs for the sidewalk spans are about 12x4 ft. They are 31¾ in. thick where they abut against the larger slabs on the bents, and the thickness is reduced to 18 in. at the abutment end.

Special slabs are used to form the parapets along each side of the bridge. They are of L-shape, 6 ft. 3 in. high and 4 ft. wide, with the exterior surfaces relieved by recessed panels, which are cast in place in well-oiled wood forms. No surface-finishing treatment is given. In each parapet slab is embedded a ½-in. electric conduit for wires to the lamps in the roof of the subway.

The tracks cross the streets on the skew, and the slabs are parallel with the tracks, so that they are all of irregular form, as shown by the plan, Fig. 3. This arrangement was adopted for convenience in construction. With one or two tracks closed temporarily, all the slabs for this part of the deck could be placed. If the slabs had been square with the abutments, the tracks would have crossed them diagonally and the placing would have been more troublesome.

The main and parapet slabs of the roadway spans contain about 15 and 11.7 cu.yd. of concrete and weigh about 30 and 23.4 tons respectively. The main and parapet slabs of the sidewalk spans contain 4.9 and 5.6 cu.yd. and weigh about 9.8 and 11.2 tons respectively.

Making the Concrete Slabs

The deck slabs (with the exception of the parapets) were made in a yard near 100th St., having two casting platforms separated by a pair of tracks. On one track ran a traveling mixer plant, the bins of which were kept supplied by a locomotive crane (with grab bucket) running on the other track. The concrete was spouted directly into the forms, which were lined with sheet steel.

About 340 slabs were made, and each was marked with a number and the date of pouring. The largest were 25

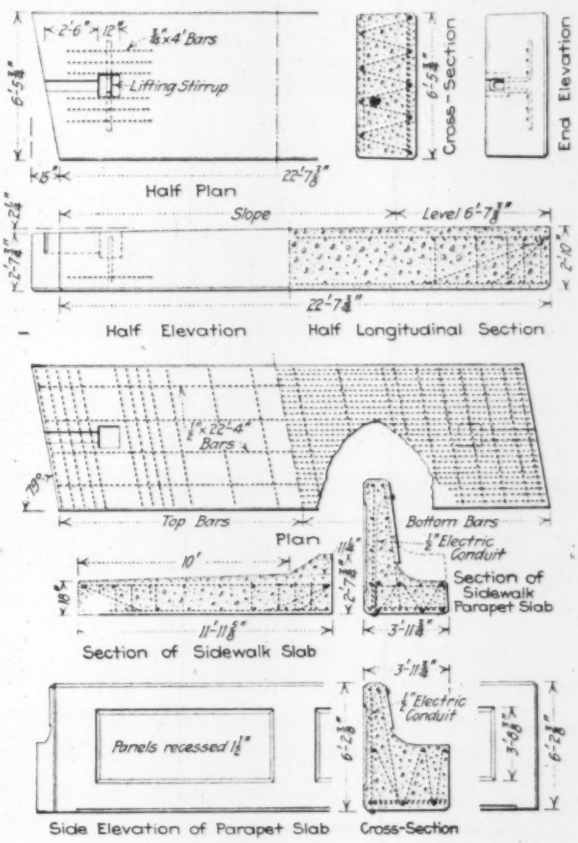


FIG. 2. CONCRETE SLAB FOR DECK OF BRIDGE

ft. in length and weighed about 35 tons. They were stacked in the yard until required, being held for 21 days, and no slab was allowed to have any load upon it until it was at least 60 days old. A railway wrecking crane or derrick-car loaded the slabs upon flat-cars, upon which they were hauled to the site, where the same crane or derrick set them in position.

The concrete is a 1:2:4 mix, using stone of not over 2-in. size. The reinforcement consists of longitudinal and transverse bars at top and bottom, some of the latter being bent up at the ends. There are also transverse stirrups at each end, and short distributing bars are laid across the feet of the lifting stirrups.

As already explained, steel construction is employed where limitations of clearance necessitate a floor of minimum thickness. The 79th St. subway, shown in Fig. 4, is typical of such subways. Here the Illinois Central R.R. crosses above the street and beneath the New York, Chi-

cago & St. Louis R.R., and the foundations include supports for the bridge of the latter road. The subway is 200 ft. long, with a width of 80 ft., except that at one end there is an additional span for the station approach, making a width of 103 ft.

There are three bents (four at the widest part), composed of steel columns spaced 14 ft. 6 in. c. to c., with cross-girders framed between them and resting on large triangular knee-brace brackets. The columns are composed mainly of pairs of 12-in. channels (flanged inward), with a plate 12x½ in. secured to their webs by four angles 4x4 in. Three of the columns support the columns of the railway bridge over the tracks. One is similar to the ordinary columns, but with 15-in. channels. The others are of specially heavy construction, owing to the concentration of loads. The girders are 48½ in. deep.

The columns and girders are incased in 1:2 cement mortar. The forms for this filling had wooden stops on the inside, to bear against the steel and insure the proper position, as the space was too restricted to permit sufficient interior inspection to see that the forms were adjusted exactly. After the forms had been removed, these stops were bored out with an auger and the holes filled with mortar.

The deck consists of I-beams parallel with the tracks. The roadway spans have 20-in. I-beams spaced 13 per panel. The sidewalk spans have 15-in. I-beams spaced 15 per panel. Concrete is filled between the beams and to a depth of 2 in. below the flanges, which are wrapped with wire netting. In the concrete are embedded wooden blocks for the trolley-wire attachments. The concrete is flush with the tops of the I-beams, and the entire floor is covered with a 2-in. bituminous waterproofing course. Drainage is provided by sloping the floor slightly to one end. The maximum thickness of this floor, including

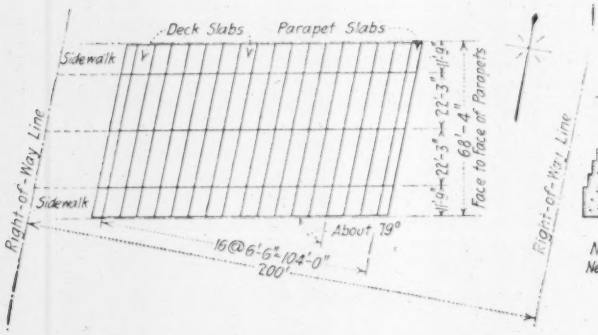


FIG. 3. PLAN SHOWING ARRANGEMENT OF DECK SLABS OF BRIDGE

under the other road, the grade had to be lowered and the lowering at 79th St. was about 11 ft. For the subway it was necessary to depress the street about 10 ft. (more than is usually the case), in order to give clearance of 13 ft. 6 in. required for streets having car tracks. The sidewalks are depressed only enough to give a clearance of 9½ ft., thus avoiding unnecessarily steep grades for the approaches and also saving in excavation and abutment masonry.

A six-track trestle was first built, and then the street was excavated by hand. The material was removed in small steel dump-cars that were pushed to an elevator tower at one end of the subway and there dumped into a bucket, which in turn emptied the material into a railway car standing on the trestle. The next step was to sink the foundation wells and build the foundation piers. An 8¼-ft. sewer had to be diverted to make way for the foundation of the central bent. A concrete box sewer was built under one roadway; and when this sewer was ready for use, the sewage flow was diverted into and out of it by wooden flumes while the connections to the sewer were being built.

In lowering the grade of the railway the steam shovel made a through cut for each track in turn, beginning at the east side. The tracks were thus lowered one by one. In placing the steel for the subway, work began at the west side and progressed across the tracks to the east. In placing the concrete deck, the work began at the east side, and successive strips were poured, each about 13 ft. wide (for one track). By working in this way the closing of tracks to traffic was reduced to a minimum.

The strip of concrete deck was dry enough in 24 hr. to receive the waterproof covering, the placing of which took about another day. The deck was then left for seven days before track was laid or any load put upon it. The

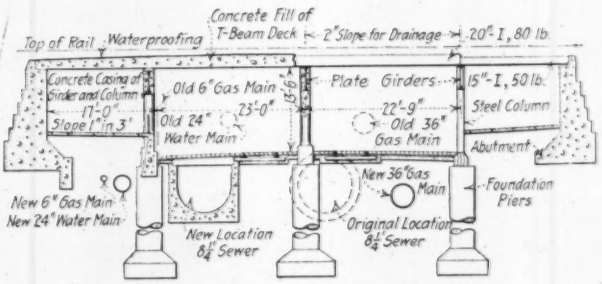


FIG. 4. STEEL SUBWAY BRIDGE FOR TRACK ELEVATION: ILLINOIS CENTRAL R.R.

waterproofing, is only 24 in. At each side of the floor is a low parapet wall of reinforced concrete.

Each column rests on a 5-ft. concrete pier sunk to hardpan at an average depth of 40 ft. Open wells were excavated in the manner common for Chicago's foundation piers and then filled with concrete. There are 51 of these 5-ft. piers and three larger piers for the columns that support upper columns for the railway bridge crossing the Illinois Central R.R. The abutments rest upon the clay, and no piles are used.

The track-elevation work was originally planned to cross above the Nickel Plate Ry. at 79th St., and the line has an ascending grade. When it was decided to pass

concrete for the abutments and the concrete filling of the deck were made in a mixing plant at one corner of the work and distributed from an elevator tower. The concrete was either spouted directly into place or spouted to a hopper, from which wheeled carts were loaded.

The contractor for the erection of the steel removed the caps and stringers of the temporary trestle, using his locomotive crane. Where this preliminary work is done by the railway company, it must use its own derrick-car, which is then in the way and interferes with other work in an already congested space. For this reason the Illinois Central and some other railways now require contractors to remove this part of the temporary work.

As the tracks do not occupy the full width of the right-of-way, retaining walls are not required. A sand-fill is built for the necessary width, and the slopes are blanketed with cinders as a protection against the wind. The filling is done by the railway forces, using side-door gondola-cars and unloading plows. At present there are six main tracks—two each for suburban, through-passenger and freight trains. There are also industry and yard connections. The traffic is heavy, and there are numerous freight-transfer movements.

The tracks temporarily come down to the street level near 95th St., where there is a grade crossing with the Rock Island lines. When these grades are separated, the street will be lowered about 8 ft. and the Illinois Central R.R. will be elevated about 4 ft. This is the third combined railway and street-grade crossing within a short distance. At 75th St. and 70th St. the Illinois Central R.R. tracks have been raised and the other lines raised still higher to cross over them. At these points the streets are depressed more than usual, so as to avoid an excessive elevation for the double-deck crossing (*Engineering News*, Nov. 4, 1915).

Engineers and Contractors

The work is under the direction of A. S. Baldwin, Chief Engineer, and F. L. Thompson, Assistant Chief Engineer. The engineer in charge of the work is M. D. Thompson. The railway company's forces built all temporary trestles, did the filling, handled and placed the concrete deck slabs, laid all the waterproofing and did all shifting and laying of tracks.

The excavation for lowering the tracks was done by J. D. Lynch & Co. The concrete work was divided between the Bates & Rogers Construction Co., the J. O. Heyworth Co. and the John J. O'Heron Co. The precast slabs were made by the C. F. Massey Co. The Ketler-Elliott Construction Co. and the Strobel Steel Construction Co. were contractors for the steelwork. Most of the street and sewer work and excavation was done by the Contracting Material Co.

The street-railway company built its own tracks, and water and gas mains were shifted by the city forces and the gas company.

Operations commenced in June, 1915. The concrete work was finished in November, and the placing of the slab decks was completed by the end of the year.

New Gravity Water-Supply for Aberdeen, Wash.

Contributed

The gravity water-supply system for Aberdeen, Wash., about to be built at a cost of $400,000, has some interesting comparative features.

The original report as to the desirability of bringing the water from the Wishkah River instead of from the Wynooche River was made to the city in June, 1915, by R. H. Thomson, consulting engineer, Seattle. The great cost of the line from the Wynooche, the larger of the two rivers, combined with greater difficulties to be encountered in the construction, rendered it advisable to consider only the possible routes from the Wishkah River and the means by which water from the Wynooche could be diverted across to the Wishkah whenever a greater future supply should become necessary.

The preliminary surveys from the Wishkah were completed by L. D. Kelsey, city engineer, last January. In a review of the two possible routes, one on a private right-of-way—line "A"—and one on a free right-of-way along the county road for a greater portion of the distance—line "B"—Mr. Thomson reported in favor of line "A," thus corroborating the findings made by Mr. Kelsey.

The attractions of route "B," due to free right-of-way and ease of access for construction along the county road, led to some discussion in council, and J. L. Stannard, consulting engineer, Portland, Ore., was called in to

WISHKAH RIVER DAM SITE, ABERDEEN WATER-SUPPLY

review the whole situation. His report, dated Feb. 29, 1916, corroborates the findings of Thomson and Kelsey in favor of route "A." This decision is due to the somewhat greater length of pipe line "B"; the greater head on the pipe by this route, requiring an additional cost of $76,000 in the one item of bands for the wood pipe; the greater cost and difficulty of laying the pipe in the side hill or bluffs along the road; and the extra cost of maintenance and of interruption to the supply in the case of slides or of flooding the line along the county road in rainy seasons.

The total cost of the system on line "A," as shown by Stannard's report, is $392,835, while by line "B" the cost was found to be $485,815. The itemized cost of the pipe line alone is as follows:

	"A" Line	"B" Lline
Lumber, $31.50 per M.	$82,864	$87,686
Bands and shoes, $3.50 per 100 lb.	76,400	152,390
Excavation and backfill	86,020	89,070
Clearing and grubbing	18,900	8,600

The pipe for line "A" would be 28 in. and for line "B" 32 in. in diameter. The diversion dam in each case would be of timber crib construction, 25 ft. high for project "A" and 55 ft. for project "B."

The possible low water-supply from the Wishkah, as found by the city engineer, is 9,500,000 gal. in 24 hr., or 0.9 cu.ft. per sec. per sq.mi. of drainage area. The Santiam River in the Willamette basin (Oregon) shows a runoff of 1.5 cu.ft. per sec. per sq.mi., and the Cedar River basin (Seattle) 0.9 cu.ft.

The city council of Aberdeen has ordered construction commenced on route "A," and contracts for lumber, bands and shoes are to be made at once. Actual construction will be proceeded with as soon as the location is made in the field.

L. D. Kelsey, city engineer, is to have charge of construction, with R. H. Thomson, Seattle, consulting engineer.

Unique Method Used To Build Rock-Fill Dam

By George W. Howson*

SYNOPSIS—Rock-fill dam of the Sierra & San Francisco Power Co., near Sonora, Calif. Exceptional features in design and method of construction. Section has three types of fill—quarry rock dropped from cableway; shaped rock laid on face; reinforced-concrete water-tight facing. Stone brought from eight quarries; from seven of these on cableways, each starting from a quarry and all centering at a movable suspended plate over the dam.

On the development of the South and Middle Forks of the Stanislaus River the Sierra & San Francisco Power Co. will shortly complete the construction of its second large storage reservoir. This development includes the construction of five storage dams, approximately 20 mi. of conduit, two high-head power plants and transmission lines, both primary and secondary.

*Chief Engineer, Sierra & San Francisco Power Co., San Francisco, Calif.

Under the progressive program of development being carried out one storage dam, one hydro-electric installation of 40,000 hp., 135 mi. of primary transmission line, with secondary transmission and distribution lines covering a large part of central California, have been completed, while the second large storage reservoir formed by Strawberry dam is nearing completion. The storage reservoirs are all above the 5,000-ft. contour, and this location, together with the natural flow, forms the ultimate source for the complete development of the two rivers. A steam stand-by station of 24,000 hp., located in San Francisco, insures continuous service.

This article covers some of the interesting features in connection with the construction and design of Strawberry dam, which impounds the second of the five storage reservoirs contemplated. This dam is located on the South Fork of the Stanislaus River, in Tuolumne County, California, 32 mi. northeast of the town of Sonora. The work is 19 mi. from a railroad, so that a long haul over mountain roads is required for all equipment, supplies and material. This long haul, together with the character

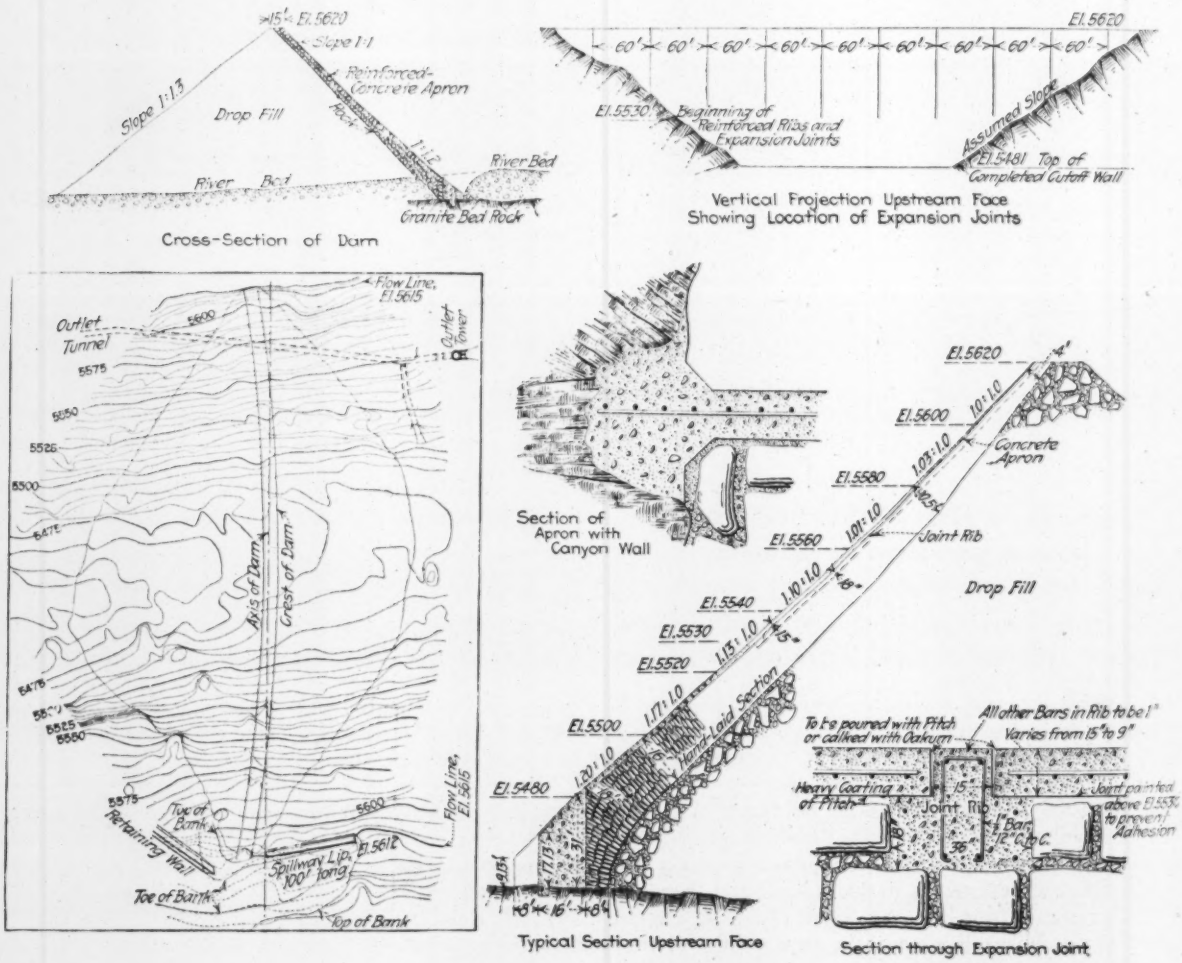


FIG. 1. GENERAL LAYOUT AND DETAILS OF STRAWBERRY DAM, NEAR SONORA, CALIF.

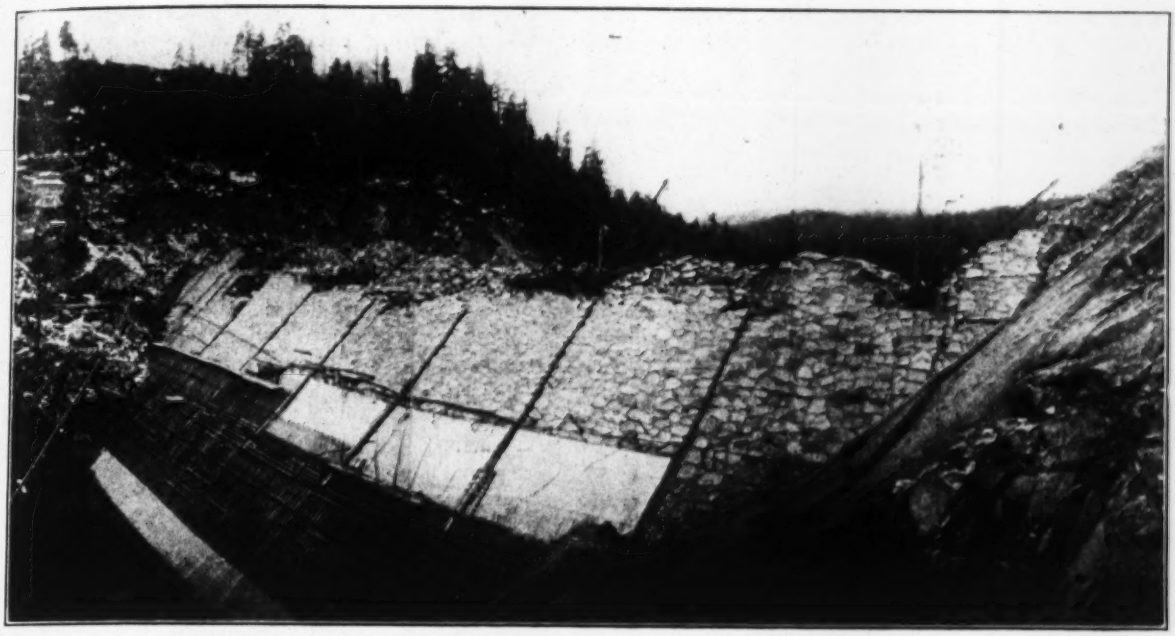


FIG. 2. UPSTREAM FACE OF STRAWBERRY DAM DURING PLACING OF FACE CONCRETE

of the foundation and excellent opportunity for quarrying rock, assisted in determining on a rock-fill type of dam.

The new dam replaces a log-crib dam built in 1861, to supply water to the Southern Mines along the Mother Lode. This reservoir has been in continuous service since constructed. The timbers forming the cribs in the interior of the structure were found to be sound and firm after 55 years' service.

Elements of the Dam Design

The dam is of that class of rock-fill structures in which the drop-fill supports the laid section under all conditions, as compared to the other class in which the laid wall assists in supporting the drop-fill under the condition of reservoir empty.

The dam is arched in an upstream direction, having a 20-ft. ordinate at the center. It is not expected that there will be an added factor of stability due to arch action in the drop-fill, but that any movement due to settlement will shorten the arch length and tend to close possible cracks in the apron. The slope of the upstream face gradually merges from 1 on 1.2 at the river bed to 1 on 1 at the crest, thus presenting a concave face to the water surface. These two curves in the general structure make the survey work arduous, but offer no difficulty from the construction point of view.

All earth and perishable material were removed from within the area of the foundation of the dam down to rock on the cañon walls and down to the level of the river bed across the floor of the cañon. At the level of the river

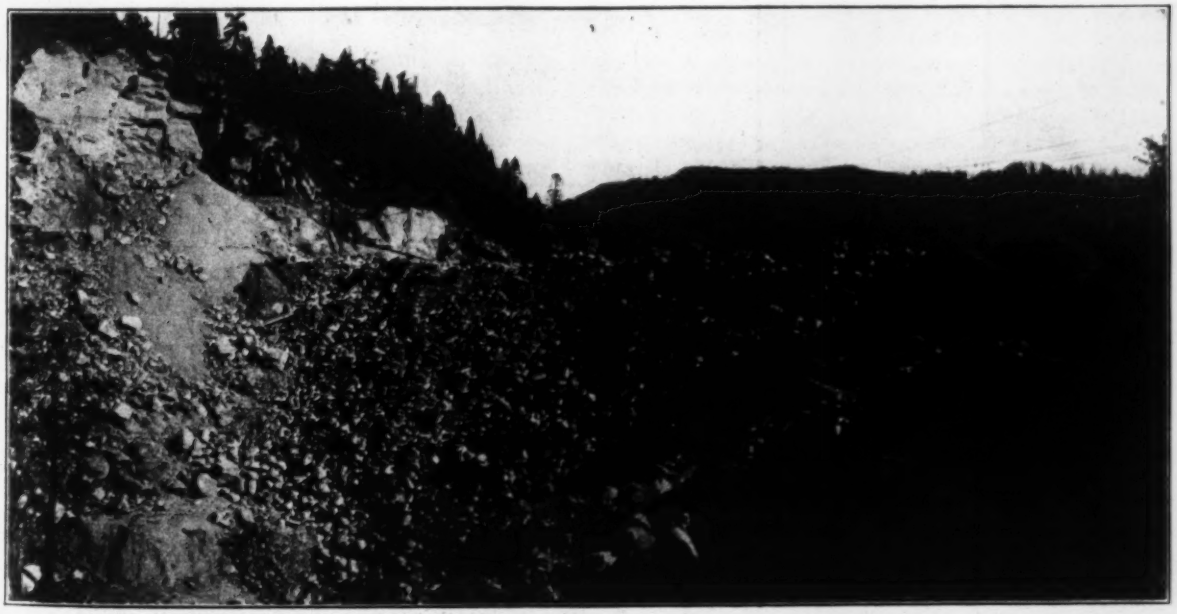


FIG. 3. EARLY STAGE IN DEPOSITION OF ROCK-FILL IN STRAWBERRY DAM

a cemented gravel, not subject to wash, was encountered. The drop-fill of the dam was built directly upon this foundation. A great many thousand cubic yards of material was excavated in preparing the foundation, all excavation across the floor of the cañon being made by steam shovel and cars, while a hydraulic giant cleared the cañon walls.

The concrete apron forming the water-tight skin on the upstream face of the dam terminates at the bottom in a concrete toe wall, which was carried down through the cemented gravel into bedrock 33 ft. below the river bed. This excavation and the concrete work were done during the low-water season of 1914, while the river could be controlled in a flume spanning the excavation. The derrick-laid section was also carried down to bedrock.

The drop-fill section of the dam was made by dropping the rock from 20 to 70 ft. from a cable system described later. This drop hammered and compacted the mass and, it is expected, will greatly reduce the amount of settlement in the completed structure. The derrick-laid section is carried back and built against the compacted and undisturbed drop-fill, thus insuring a solid, firm backing for the laid section that must support the concrete apron and water load.

The concrete apron is cast monolithic from the toe wall up for one-third the height of the dam and from cañon wall to cañon wall. The upper two-thirds of the apron is designed with vertical expansion joints spaced 60 ft. These joints butt up against and are supported by concrete ribs built into the laid section. Between these expansion joints the apron is free to slide upon a smooth plastered surface. It is expected that this sliding plane will prevent cracks in the apron due to temperature stresses or to settlement in the dam structure. The entire apron is heavily reinforced, as shown in Fig. 1.

Water is drawn from the reservoir through an outlet tunnel 600 ft. long cut through solid rock at one end of the dam. An outlet tower at the upper end of the tunnel, with six 30-in. sluice gates radially spaced at various elevations, will control the water entering the tunnel, while more refined regulation by needle valves will be possible at the discharge end. This duplicate regulation is an insurance against the loss of water, and the refined regulation is very desirable on account of the large value of the water for power purposes through the 3,300-ft.-head available.

The spillway is cut through solid rock adjacent to one end of the dam. The spillway lip is 8 ft. in elevation below the crest of the dam and has a length of 100 ft.

Seven Quarry Cableways Center Above Dam

The rock for the structure is being obtained from eight quarries, one operated with a steam shovel and construction trains, while the rock from the other seven quarries is transported by cableways. An original method of transporting and delivering the rock to the fill was developed on this work—namely, having a system of cables all radiating from a central steel plate suspended over the fill to secure anchors back on the hillside above the quarries. Each cable performs the double function of being the carrying cable from its particular quarry and of acting as a guy line for the remainder of the system. The center steel plate, called the spider (from the similarity of the system to a spider web), is always maintained as the lowest point of the system.

The rock from each quarry is delivered to the fill by a single-line hoisting engine, which hoists the load from the quarry pit to the carrying cable, where a mechanical device engages the carriage and the load runs out over the fill by gravity. The load is discharged automatically at a bumper, after which the carriage is again drawn back by the single-line hoist until it again strikes the mechanical device over the quarry pit, which automatically trips and allows the line to lower to the quarry. The round trip requires about 2 min., while the maximum distance of delivery is approximately 800 ft. Loads of 5 tons were readily handled on 1¼-in. cables.

The entire system is very flexible, as the central plate is readily moved to different points of the fill by taking in and letting out on the proper cables, and the position of the bumper on any individual line is quickly changed. This method of transporting and placing material is the fastest and most economical that has come to the author's attention and is the outgrowth of much study and experimenting in connection with making the large fill at the Strawberry dam.

All rocks in the laid section are handled by derricks. One of the striking features is the quality of this work. Face rocks are selected stones, carefully set to line, a variation of 3 in. from the theoretical line being allowed. These rocks vary from 2 to 5 tons and are all well supported and wedged tightly in place.

The dam is being built for the Sierra & San Francisco Power Co. by Chadwick & Sykes, general contractors. H. L. Livingston is superintendent for the contractors and J. S. Malony for the power company. F. I. Doane is assistant engineer. Ford, Bacon & Davis, New York City, who are engineers for the power company, prepared the plans and estimates. The work is being carried out under the direction of H. F. Jackson, Vice-President and General Manager of the power company, under the immediate supervision of the author, in general charge of the extensions of the power company's hydro-electric developments. M. M. O'Shaughnessy was consulting engineer.

Gen. William Sooy Smith

Gen. William Sooy Smith, who died of pneumonia on Mar. 4, at Medford, Ore., where he had resided since 1910, was in his eighty-fifth year and was one of the very few men still surviving who were prominent in American engineering work prior to the Civil War.

He was born of Quaker parentage at Tarleton, Ohio, July 22, 1830. He worked his way through Ohio University, graduating in 1849. He at once entered West Point and graduated sixth in the class of 1853. His military title was won later, however, for he soon resigned from the army to engage in civil-engineering work. In this field he displayed the originality and resource that made him widely known in the profession.

In 1869, as engineer for the New Jersey Steel and Iron Co., he built a bridge for the Charleston & Savannah R.R. across the Savannah River. The pier foundations were being sunk by the pneumatic process, which had just been introduced into this country from France; and the design of the apparatus as copied from the French practice was crude and ineffective. All the material excavated had to be hoisted in bags and handled through a small air lock. Smith built a much larger lock, in

which a considerable amount of material could be accumulated and hoisted out in bulk. He then developed the plan, which has ever since been used, of blowing out the loose material by permitting the air to escape through a pipe.

The origin of this latter process was as follows: One of the cylinders in process of sinking reached a stratum so impermeable that the air pressure did not force out the water inside the cylinder. A pipe was therefore run down through the air lock to the bottom of the caisson, so that the air pressure would force up the water through this pipe. When the pipe reached the sand bottom, it was found that the sand as well as the water was rapidly being driven out through it. A telescopic section was therefore put on the bottom of the pipe, and four laborers were put to work shoveling sand to the bottom of it, to keep it buried. According to Gen. Sooy Smith, on this piece of work this method of removing material from the caisson made it possible to excavate the material 24 times as fast as before.

It was while this work was in progress that the outbreak of the Civil War put a stop to civil-engineering work for a time. Gen. Sooy Smith at once returned to Ohio and enlisted in the volunteer army, being commissioned lieutenant-colonel and assistant adjutant-general. At the expiration of the three months' enlistment period, when the Ohio regiments were reorganized for three-year service, he was made colonel of the 13th Ohio Infantry. He served in the campaigns in West Virginia and was then transferred with his regiment to the Army of the Ohio. He was made brigadier-general for his service at the battle of Shiloh and was later on the staff of Grant and of Sherman; under the latter he was chief of cavalry of the Mississippi Division.

In 1864 a serious attack of rheumatism compelled his resignation from the army. After his restoration to health he again engaged in civil-engineering work, devoting himself largely to railway-bridge construction, especially in connection with the development of the pneumatic process. In 1876 he made designs for a double-track railway tunnel under the Detroit River. He proposed to build it by sinking a continuous series of pneumatic caissons across the river. His plan received the approval of a board of prominent engineers appointed to consider it; but the suggestion was in advance of the times, and it remained for the engineers of a later generation to carry out the plan in modified form.

When the manufacture of steel as a structural material began, he was one of the first to advocate the use of steel instead of iron as a bridge material. President Blackstone, of the Chicago & Alton R.R., appointed Gen. Sooy Smith chief engineer of the bridge over the Missouri River at Glasgow, Mo., and it was decided that the trusses should be made exclusively of steel. At that time the great weight of opinion among engineers was against the use of steel for bridges, on account of its variability and erratic behavior when subjected to shock and vibration, and this bridge was the first large all-steel truss bridge built in the world.

Soon after, Gen. Sooy Smith was chairman of a committee appointed by the American Society of Civil Engineers to secure from Congress an appropriation for an investigation of the properties of iron and steel. After the appropriations were secured, he was appointed one of the members of the Testing Board.

Another notable improvement with which Gen. Sooy Smith's name is connected was the introduction into the United States, in association with his son, Charles Sooysmith, of the freezing process of excavation, in the late 80's.

Most of the later years of his life were spent in Chicago, and in that city he was among the first to advocate the sinking of deep foundations for high buildings, carrying piers down to the rock, in place of the raft or grillage foundations that were used for the first high buildings there. During his years of professional work Gen. Sooy Smith acted as contractor as well as engineer on many of his important works. He was associated with the first attempt to build a subaqueous tunnel across the Hudson River at New York City, under Haskins in the late 70's. This was prior to the invention of the tunneling shield and unfortunately ended in failure. In his active years Gen. Sooy Smith was a member of numerous clubs and engineering and scientific societies. He had been a member of the American Society of Civil Engineers since 1872 and was president of the Western Society of Engineers from 1877 to 1880.

Specifications for Treating Wood with Creosote*

By Kenneth Redman†

To a newcomer in the creosoting business the specifications now in vogue for the treatment of Douglas fir on the Pacific Coast seem to be based upon a fundamentally wrong principle. All the more important specifications contain detailed restrictions and limits prescribing exactly the manner of treating, leaving no latitude to the treating engineer, whose business it is to know how to deal with the timber.

When these specifications were drawn up, much less was known of the actual safety limits in using the boiling process than is known today. There have been but slight changes in the specifications, but the treating companies have now learned the limits within which they may safely work. This knowledge has been acquired largely by extended and costly experience. In no instance have the specifications that tell the companies how to treat been of any assistance to them.

It is no uncommon occurrence, when two orders are being handled at the same time—the one under strict specifications and the other with no specifications at all—to have that material which is treated according to the specifications turn out of poorer average quality than the other. The loss due to cullage, however, is borne entirely by the treating company, which is thus fined for complying with instructions. Is this just?

A specific instance, which is typical, may be cited. The specifications of a majority of the railroads stipulate that the boiling of green piling shall be conducted at a maximum temperature of 225° F. To treat in this manner requires 48 to 60 hr., and longer for large pieces. Even then the engineer is at a loss to know exactly when his material is thoroughly dry, for there are often intervals of 3 to 5 hr. during the boiling when the condensation will drop to the required ⅛ lb. per cu.ft.

*Condensed from an article prepared for the Forest School University of Washington.

†Acting Superintendent, Pacific Creosoting Co., Creosote, Wash.

per hr. Were the engineer to press the load the first time that the condensation dropped to the required point, there would result badly split wet material with insufficient protection—that is, culls. This state of affairs caused the companies to operate partly on a time schedule, which is haphazard and unscientific.

Whenever the specifications permit, the present treatment of such material is to boil at 230 to 235° F., and in approximately the last 5 hr. to advance the temperature 5 to 10° more. By this method the time is cut to 32 to 40 hr. The final rise in temperature, when accompanied by no material increase in condensation, is proof to the engineer that this material is in proper condition to receive the oil. Furthermore, as evidence that the companies do not care to boil continuously at high temperatures even when unrestricted, there is in force today a standard specification that permits boiling at 240° F., but the company avails itself of the 240° only in the last few hours of the bath. Were the specifications to permit a maximum of 260°, the company would not alter its method.

Now, it is to the interest of the treating company to produce the best material possible, in order to gain and hold business. Any restrictions that hamper this result work injustice, not only to the company, but to the purchaser as well. The oft-heard lamentation of the inspector that it is too bad the material is spoiled is poor recompense for the culled material accumulating on the hands of the company as it vainly endeavors to treat successfully as it is told.

To keep abreast of all innovations and to try out thoroughly all suggestions for improving present methods, the companies maintain and operate experimental plants, complete in every detail. These experimental plants have furnished data of a practical nature that enable the treating engineer to handle his material with very nearly a certainty. This knowledge, coupled with their extensive experience, justifies the companies in prescribing the precise manner in which the material is to be treated.

Effective specifications for timber treatment should include the following points: (1) Quality of oil to be used; (2) quality of material in the green; (3) quality of treated material; (4) minimum protection required.

Let us see if these points do not protect the buyer's interest fully as well as, if not better than, the present specifications. Buyers are usually represented by inspectors of experience. Practical inspection consists of examining the physical condition of the treated material as regards splits, ring-shake, straightness, etc., together with the stipulated protection. If the material is sufficiently protected and physically fit for the purpose intended, as stated in the specifications, it is accepted for the buyer. Some of the material that is accepted, however, is a "liner"; that is, the inspector is not justified in refusing it, yet it could have been a better product, either as regards soundness or protection.

Now, by granting to the treating company a free rein in the details of its treating operations, but at the same time holding a check on its completed product, the company can so treat that there will result to the buyer a much smaller percentage of "liners" and an average higher-grade material. It is to the buyer's interest, therefore, that he permit the treating company to use all the skill and knowledge at its command in producing his material. The benefit of the foregoing specification to the company is that it will have less needlessly culled material left on its hands.

The writer has discussed this matter with one of the eminent structural engineers of California and has been assured that his next specifications will be framed along the lines here suggested. It is to be hoped that other engineers will see the advantages of such specifications.

Reducing Slippery Pavements in San Francisco

By A. J. Cleary*

Skidding vehicles on wet streets are a menace that the street maintenance and repair departments of the Board of Public Works of San Francisco are endeavoring to overcome. Two distinct modes of protection have been introduced—one for the level business districts, another for the hillside residence sections where the grades are less than 12%. On steeper grades basalt block or vitrified brick is employed.

In the level districts an asphalt wearing surface on a 6-in. concrete foundation is in general use. The advantages of this type are smoothness, noiselessness under traffic, appearance, and economy of construction ($2 per square yard). The most important objection is the slipperiness of such a pavement when wet.

FIG. 1. SHOWING A FINISHED SURFACE; HALF OF STREET RESURFACED WITH ASPHALT AND ROCK

To obviate this objection as much as possible, the Board of Public Works has ordered that the most extensively traveled asphalt streets in the downtown district shall be sprinkled with sand whenever weather conditions make such a precaution advisable. To make this operation as inexpensive as possible, D. J. McCoy, Superintendent of Street Repairs, has invented a special sand spreader (Fig. 3), which can be attached to the rear axle of a motor

*Assistant City Engineer, San Francisco, Calif.

FIG. 2. RENDERING ASPHALT WEARING SURFACE NONSKID BY HEATING IT, DUMPING CRUSHED ROCK, AND ROLLING WHILE STILL HOT

truck, at a total expense of about $275. It has proved to be a very efficient and economical device.

The spreader consists of a flat steel disk that can be rapidly rotated, to which sand is fed through a hose from a hopper on the rear of the truck. The disk is rotated by gear connection to the driving shaft of the truck. On the disk are curved blades that give the sand a strong centrifugal impulse when the disk is rapidly rotated. With the truck traveling on second gear the width of the sand spray is 80 ft., and its density can be regulated by the amount that is fed from the hopper to the disk.

Coarse river sand is best adapted to securing nonskid streets. To prevent slipping, it must be free from clay; and to flow freely, it must be perfectly dry. In San Francisco the cost for spraying 100,000 sq.yd. is $8. This price includes rental of motor truck, services of driver and cost of sand.

In resurfacing asphalt streets in the hillside residential sections the Lutz surface heater has been efficiently used. An innovation introduced by Mr. McCoy has been the spreading of rock on the surface heated by the machine, and rolling before the material cools. This plan has given a satisfactory nonskid asphalt surface. Its only defect is the tendency of the asphalt to spread over the rock under very heavy traffic. Many pavements resurfaced in this manner for experimental purposes several years ago are still in excellent condition. One cubic yard of rock is sufficient for 30,000 sq.ft. Resurfacing costs 5.3c. per square foot in San Francisco.

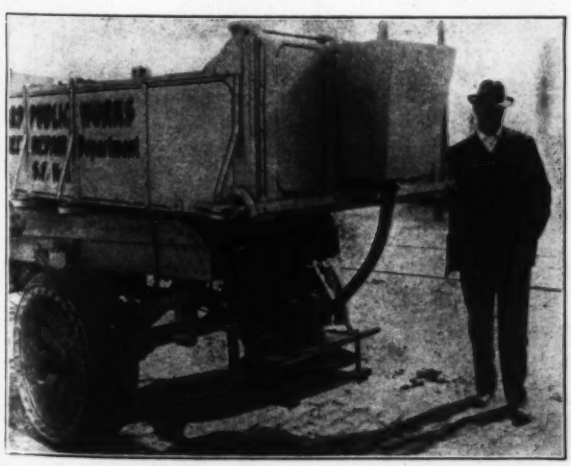


FIG. 3. McCOY SAND SPREADER IN SAN FRANCISCO

Ontario Purchases Big Private Power System

It is officially announced that the Ontario government has completed an agreement for the purchase at $8,350,000 in Ontario 4% bonds of the entire assets of the Electrical Power Co. in central and eastern Ontario. This includes complete control of 22 subsidiary companies now distributing power and light between Toronto and Kingston and as far north as North Bay—namely, Auburn Power Co.; Central Ontario Power Co.; City Gas Co., Oshawa; Cobourg Utilities Corporation; Cobourg Water and Electric Light Co.; Cobourg Gas, Electric Light and Water Co.; Eastern Power Co.; Light, Heat and Power Co. of Lindsay; Napanee Gas Co., Ltd.; Napanee Water and Electric Co.; Nipissing Power Co., Ltd.; Northumberland Pulp Co., Ltd.; Oshawa Electric Light Co.; Otonabee Power Co.; North Bay Light, Heat and Power Co.; Port Hope Light and Power Co.; Peterboro Light and Power Co.; Peterboro Radial Railway Co.; Seymour Power and Contract Co.; Trenton Electric and Power Co.; and Tweed Electric Light and Power Co. This will make the whole of the power of the Trent Valley system available for distribution by the Provincial Hydro-Electric Commission at cost, putting the central and eastern districts of the province in the same position as regards power supply as the western section is with Niagara power. Nearly all the water powers of the Trent River were alienated by the Ottawa government to private interests, and many of them have remained idle. The government has another project under way, by which the hydro-electric system will be farther extended to serve the extreme east of the province.

Field and Office

Electric Shovel with Hydraulic Transmission Gear

Successful application of electric drive to a power shovel has been accomplished by Frank H. Armstrong, Mechanical Engineer of the Penn Iron Mining Co., Vulcan, Mich. On account of the extreme fluctuations of power demand, it was necessary to employ a hydraulic system, inserted as a yielding link between motor and shovel. The several motions of the shovel are actuated by hydraulic cylinders, all supplied from a motor-driven centrifugal pump.

This electro-hydraulic shovel has proved very satisfactory in operation after the elimination of early detail troubles. There are no severe load-peaks on the electric system, the maximum power drafts being only 30% in excess of the mean, which is 100 kw. The peaks, of course, could be entirely eliminated by a larger hydraulic accumulator. The control of the shovel is smooth and accurate. The water pressure is 275 lb. per sq.in. and is obtained with a four-stage centrifugal pump driven by a 200-hp. 1,200-r.p.m. 2,200-volt induction motor. The valves used at first were leather packed, but these gave trouble from sticking. The present valves have no leather in their construction and are proportioned to give a gradual opening and closing of the passages, to prevent water-hammer.

The dipper is hoisted by means of a large single-acting cylinder and plunger. A double hoisting rope passes around two sheaves at the outer end of the plunger, one end of the rope being fastened to the front flange of the hoisting cylinder, while the other is fastened to the dipper, which travels 2 ft. for every foot the plunger moves. The weight of the dipper throws back the plunger when the valve is opened to exhaust. The boom is swung by a double-acting cylinder, the piston rod of which extends through each cylinder head and has a sheave at each end. Thrusting is accomplished by rams acting directly on the diper handle. The ram piping is made with swivel and sleeve joints, so that the dipper can be raised or lowered, or the broom swung or raised.

The shovel is operated by one man, as indicated at the right in Fig. 2. At his right hand is the thrust-control lever, on which is a button for tripping the dipper. On his left is the hoist control. His feet operate the swing

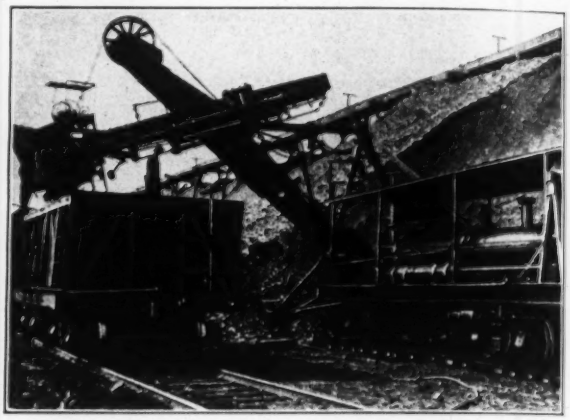


FIG. 1. ELECTRO-HYDRAULIC SHOVEL IN OPERATION

valves. The shovel is propelled by a second motor, the handle of the controller of which is seen under the man's right elbow.

The dipper is tripped by a solenoid shown in Fig. 2 (at the left is the dipper about to dump, and in the middle the trip weight is released and the dipper door open). The average speed of the machine is three or four dippers per minute; 3,000 tons has frequently been loaded in a 10-hr. day.

An advantage of electric power is that when the shovel is not in operation, the current can be shut off and the pump stopped. A possible advantage for city work is the comparative noiselessness of the machine.

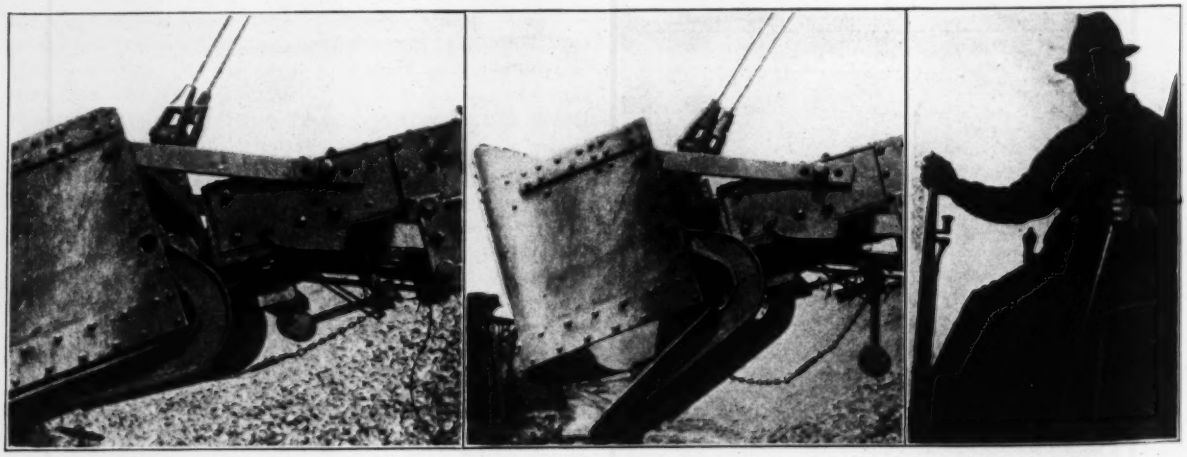


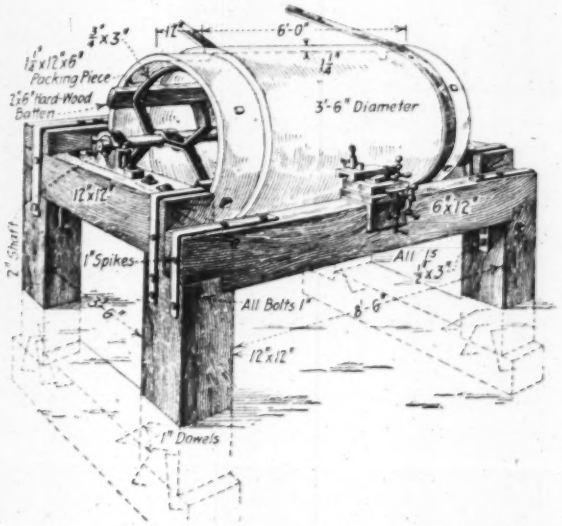
FIG. 2. LEFT—DIPPER CLOSED. MIDDLE—WEIGHT RELEASED AND DIPPER OPEN. RIGHT—THE OPERATOR

Improvised Lathe for Bridge-Pier Cylinders

By Leonard Goodday*

Engineering News, July 8, 1915, contained an article on the method I adopted for making the curved leaves for a clamshell excavator that I manufactured 56 mi. from Adelaide, South Australia, in excavating for 33 pairs of cast-iron cylinders for the railway-bridge piers in the Murray swamp. I now propose to explain how the "making-up pieces" were cut for these cylinders by improvising a rough-and-ready lathe that gave every satisfaction.

With 12x12-in. Oregon logs and half-logs the frame for a lathe was constructed. At each end of it plummer



IMPROVISED LATHE FOR CUTTING BRIDGE-PIER MAKE-UP CYLINDERS

blocks were fixed for a 2-in. shaft having collars to prevent any lateral movement. Two sets of frames were made and bolted to the shaft, as shown in the sketch, 6 ft. apart, in such a way that a cylinder could be securely fixed to them, as follows: Packings 1¼x6x12 in. were placed at the bottom end in the joint, and four 2x6-in. battens were run through the cylinder, against which the two iron-bar frames were fixed—one at each end—with four 1¼-in. bolts through the holes for fixing the cylinders together when in place, the 2-in. shaft being fixed, as shown, by two 1-in. bolts at each end.

The cylinder was then slung by a derrick (which was just in front of the lathe) into place in the plummer blocks, and the "caps" were adjusted. A 6-in. belt from a stationary engine, used to run a crusher, was slipped on the cylinder, which became its own pulley. Iron rods were used to prevent the belt running along the cylinder laterally, the latter of course not being "crowned." The speed for turning cast iron—150 to 170 ft. per min.—was governed by simply regulating the speed of the engine so that the cylinder revolved at from about 14 to 16 r.p.m.

When cut, the plummer caps were taken off, the cylinder was slung, and lifted out with the slings, blocks and fall suspended overhead from the derrick. The lathe was placed near the edge of the river bank, where a chute was built down to the waters edge. After the shaft, iron frames and packing, etc., were taken away, the "making-up piece" was then lowered down the chute and onto the lighter, ready to be carried across the river with the other parts. The slide rest and cutting tools were sent from the Adelaide locomotive shops.

*62 Craig St., Ottawa, Canada.

Status of the Air Tie-Tamper

Pneumatic tie-tamping machines have reached a high state of development in the two years they have been in commercial use. They are now a standard track tool in the maintenance-of-way department of many steam and electric railways. Hand tamping did well enough in the past, but in this day of labor shortage the semi-mechanical method is more desirable. As an indication of the status of this method, the Pennsylvania Lines East alone have 150 of these tampers in service, according to the Ingersoll-Rand Co.

Air tampers can be operated from pneumatic signals or other air-power lines. Pneumatic signal lines are usually at 110-lb. pressure, but the switches will operate satisfactorily on 60 lb., allowing ample leeway for a drop in pressure from any cause whatever. The Pennsylvania operates tampers on these air lines and experiences no difficulty from lowered pressure, although as many as four tampers have been used at one point. Where air is not available, a self-propelled compressor-car is provided. This is built in two sizes—for two tampers and four tampers respectively. The power is furnished by a gasoline engine. The maximum speed loaded is 15 mi. per hr. On electric street and interurban railways power usually is obtained by the use of a motor-driven compressor, mounted for coupling to a work-car or a regular steet-car. Whenever a large number of tamping machines are required, as in laying new track, a standard steam- or electric-driven compressor can be installed in a work-car.

Portable compressor plants of two- or four-tool capacity cost from $2,000 to $2,500 each, making a rather large investment for only one class of work. These power plants, however, can also supply air for such purposes as boring spike-holes, tightening bolts, drilling and reaming bolt-holes and bond-holes in rails, driving rivets and chipping metal in steel-culvert, bridge and cattle-guard work, tamping earth around culverts, driving plug drills in rock excavation, operating pumps, hoists, jacks, concrete mixers, etc.

Tamping bars for different thicknesses of face are provided for tamping the various kinds of ballast. The thickest tamping bar is that used for cinders, earth, gravel, sand or chat. The thinnest head is for rock ballast of 2-in. mesh or larger. The bars in each case are 18 in. long, with a face 3 in. wide.

The "Imperial" tie tamper weighs 37½ lb. Its best operating pressure is 65 to 75 lb., its consumption at 70 lb. being 16 cu.ft. of free air per minute. The two-tool "Imperial" gasoline-engine-driven compressor-car weighs 2,000 lb. (without hose or tampers). It is 9 ft. 9 in. by 5 ft. 7 in. in plan by 5 ft. 6 in. high and will carry 12 men with equipment. The air capacity is 45 cu.ft. of free-air piston displacement per minute. The gasoline consumption at full load is 1¼ gal. per hr. The tank capacity is 15 gal.

Bridge-Track Repairs, Sixth St. Bridge, Pittsburgh

It was recently necessary to make extensive alterations in the street-railway tracks crossing the Sixth St. bridge, Pittsburgh, mainly because of the bad condition of joints, owing to flexibility of supports. The bridge was built in 1893 and has a buckle-plate floor, with buckles turned up. The street-car rails had been bolted to the domes of the buckle plates, which gave a spacing of supports of 3 ft. 2½ in. The rails in use were Lorain Steel Co., Section 107, No. 333. Besides the poor riding qualities the spacing of tracks was so small (only 8 ft. 7½ in.) that any faulty alignment of the track, either vertically or horizontally, allowed the big suburban cars to scrape and often actually block each other.

For these reasons it was necessary to increase the spacing of the tracks and to improve the supports. The two stringers, 18 in. apart, which are shown in Fig. 1, were originally provided to give a cableway for cable cars, but have never been used for that purpose. They happened to be so spaced, however, as to come directly under the line of rails when these were moved down off the top of the buckle plates. The rivet spacing in the top flange of these stringers, connecting to the buckle plates, was 4 in., except at a few points in each panel. A structural-steel chair was designed to engage four of these rivets, and at intervals of approximately 24 in., the rivets were cut out and the chairs riveted on. The chairs were made in a structural shop by bending hot in a bulldozer. Metal ¾ in. thick was used, for stiffness and permanence.

The new tracks are 12 ft. 5⅜ in. c. to c., a considerable increase over the Pittsburgh Railway's standard of 9 ft. 6½ in., but made necessary by the spacing of the stringers.

In laying the new rails care was taken to get the joints midway between supports. Vertical alignment of the rails was secured by using shims under the base of the rail, and horizontal alignment was made with wedges (Fig. 1). The maximum lateral adjustment of ⅞ in. provided by the wedges proved just sufficient to take up all irregularities in the position of the chairs and align the rails. As the concrete base covers these wedges, they are secure against movement after once being adjusted.

The buckle plates were of metal only $\frac{5}{16}$ in. thick. It had been feared that when the concrete, which covered them to a depth of 4½ to 6½ in., was removed, they might be found badly corroded in some places. Actually, they were found in excellent condition and in many cases were as bright as when they left the mill.

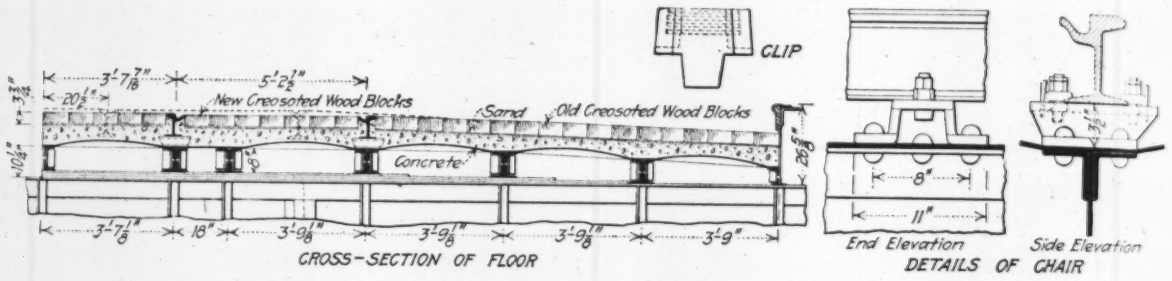


FIG. 1. TRACK DETAILS OF THE SIXTH ST. BRIDGE IN PITTSBURGH

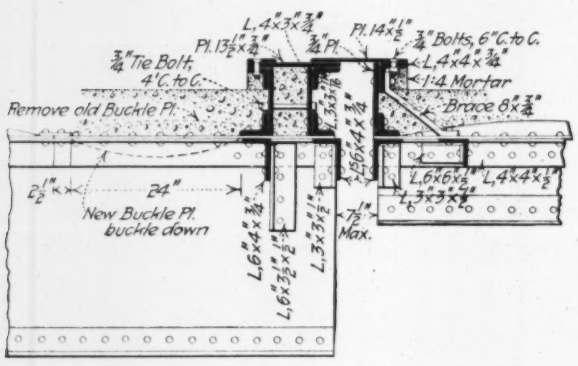


FIG. 2. DESIGN OF ROADWAY EXPANSION JOINT

Heavy new roadway expansion joints were provided, as shown in Fig. 2. For the street-railway tracks a patented expansion joint of arrow-head shape, made by William Wharton, Jr., & Co., Philadelphia, was used. This joint has been very successful in several installations on bridges around Pittsburgh. The wear plates of manganese steel are kept tight against the tapered rail at all temperatures by heavy springs incased in the cast-iron frames.

The repair work was done by Allegheny County, owner of the Sixth St. bridge, under the supervision of J. G. Chalfant, County Engineer, and V. R. Covell, Deputy County Engineer.

A Light Wooden Roof Truss for Canvas Inclosure

By Clyde B. Chace*

The accompanying sketch shows a wooden truss interesting on account of lightness of weight and thorough adaptation to the materials, workmen and methods found on a concrete building.

On the Missouri Can Co.'s new buildings in North Kansas City, Mo., it was found necessary to form and concrete the monitor, or elevated center panel of the roof, during the most severe part of the winter. This panel is 21 ft. wide. Protection was furnished by constructing a canvas shed resting on the adjoining part of the roof, which was already concreted. This shed completed the canvasing in of the portion of roof already concreted, which was heated during the construction of the monitor.

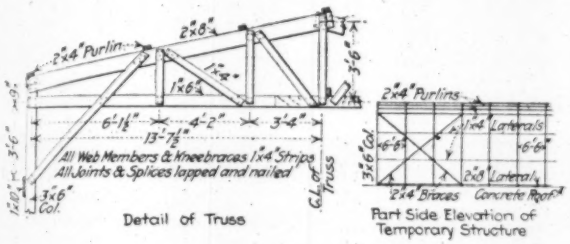
The shed was 180 ft. long. Its frame consisted of trusses supported by 3x6-in. columns. It was made wide enough to allow work on the forms for the columns sup-

*4126 Virginia Ave., Kansas City, Mo.

porting the monitor and high enough to permit a man to walk on the monitor roof without stooping. A clear span of 26 ft. 9 in. was used, and the trusses were spaced 6½ ft.

All lumber used in the shed had previously been used in the forms for the floors below. The 3x6-in. stringers of the flat-slab forms made the columns; the 2x8-in. by 14-ft. joists made the top chords of the trusses; 1x6-in. flooring the bottom chord; and 1x4-in. short ties furnished the web members. Any convenient 2-in. stuff was used for purlins, 2x4's being preferred.

As will be noticed, the trusses were admirably adapted to rapid construction. All joints were lapped and nailed, and little sawing was required, except on the web mem-



WOODEN TRUSS FOR CANVAS HOUSING IN WINTER CONCRETING

bers. A whole truss and its columns formed the unit of fabrication, which was done in a horizontal position as near where the unit was required as possible. Erection consisted simply in tripping up the bent and securing it top and bottom. Diagonals across four bents were placed on each side of the shed at the ends and center. After the first set of braces was in place, the trusses were readily secured by fastening each successive bent to the one just erected. The major portion of the fabrication and erection was done in a single day by the carpenter force on the job.

The trusses were designed by Peter Olson, superintendent for the contractors, R. F. Wilson & Co., Chicago.

Pulling a Displaced Steel Foundation Cylinder

In the construction of the foundation of the new Lincoln Memorial on the Mall at Washington, D. C., the subfoundation was made up of a number of reinforced-concrete piers placed inside steel cylinders ½ in. thick for the lower 20 ft., ⅜ in. thick for the remainder and varying in diameter from 3 ft. 6 in. to 4 ft. 2 in. They are from 45 to 50 ft. in depth. The cylinders were sunk to rock by loading them and excavating the interior earth; the reinforcing steel was then placed and the cylinders filled with concrete.

Several old piles were encountered in the sinking process. Fortunately, most of them came inside the cylinders and could be dug out. One pile, however, caused a cylinder to sink 3½ ft. out of plumb and so disturbed its location as to require it to be withdrawn and sunk again. To pull out the cylinder, a somewhat novel method was used, as described by Capt. James A. O'Connor, Corps of Engineers, U. S. A., in a recent paper in "Professional Memoirs, Corps of Engineers, United States Army and Engineering Department at Large."

First, an air-tight bulkhead of 6-in. timbers was fastened to the top of the cylinder by angle irons. Ground water was allowed to fill up the cylinder to the bottom of the bulkhead; an upward strain of over 50 tons having been put on the cylinder by means of jacks and chains, air under 100 lb. pressure was led to the inside of the cylinder, and repeated impulses were given to the bottom of the bulkhead by opening and shutting the air valve. Careful observations on the gage showed a pressure of 90 lb. per sq.in. for several moments after the valve had been opened. The first twelve attempts raised the cylinder a total of 1 in., the strain on the jacks being taken up each time. On the next attempt the cylinder shot up 15 ft. and was then easily removed.

Specify Amount of Formwork

By S. P. Baird*

Different contractors have different ways of arriving at the cost of concrete, but all their methods take into consideration the amount of forms necessary. When the design of a piece of concrete work is made, it would be an easy matter to calculate once for all the amount of contact surface for the various grades of concrete making up the structure.

For instance, if there were an arch culvert to build on which bids are to be asked, the footing concrete might be as lean as 1:3:6 and no forms required. The bench walls might be of 1:2½:5 concrete and the barrel of 1:2:4. The bench walls would require forms both at the front and the rear of the walls, and with some designs the ring or barrel would only necessitate forms on the under side and at the ends, while the head walls would call for forms both on the sides and on the ends. Following my suggestion the bids would be asked for on something like the following:

100 cu.yd.	1 : 3 : 6	27 excavation
110 cu.yd.	1 : 2½ : 5	9 face; 9 back
90 cu.yd.	1 : 2 : 4	13 face supported 1 face 2 back

Once the system were established it would be intelligible to all and would be interpreted as follows: For the first item it would be 100 cu.yd. of 1:3:6 concrete deposited in an excavation. The surface of the excavation in contact with the concrete would be 27 sq.ft. for each cubic yard of concrete. For the second item the interpretation would be 110 cu.yd. of 1:2½:5 concrete, with 9 sq.ft. of face forms and 9 sq.ft. of back forms per cubic yard of concrete. The last item would indicate that there will be 13 sq.ft. of face forms (the weight of the concrete must be supported at the under side of the arch) for each cubic yard of concrete. The company asking bids would get lower prices, and it would be fairer for the company to calculate it once than for 20 contractors to have to work it out for themselves.

Getting Freight Cars for Automobiles—Charles Shaar, traffic manager of the Packard Motor Car Co., has partly solved the railway-car shortage problem by the erection of sturdy superstructures on railroad "gondolas." These housings, which protect the shipments practically as well as the regular automobile freight cars, are made the means of getting the car back in a hurry. When the covered gondola reaches its destination, the dealer is instructed to bill the superstructure back as a carload of lumber, tar paper, etc., which it really is. In this way the car is returned quickly to the factory and can be used for other shipments.

*Columbus, Ohio.

Concreting Piles with a Tremie

By Rudolph N. Maxwell*

In driving piles for the foundations of the new Hopple St. viaduct at Cincinnati, Ohio, water in many cases was encountered from several old sewers on the site. Raymond concrete piles were used under many of the piers, which made it necessary to place the concrete through this water. In a particularly aggravated case, water from one of tre sewers flowed in over the top of the 20-ft. shell much faster than it could be pumped out.

To correct this condition, three sections of smaller-diameter shells were fitted into each other, forming a cone-shaped tube. A rope was fastened around the top of this improvised tube, which was then lowered into the water-filled pile hole to a point about 2 ft. above the bottom. This inner shell was allowed to project at the top about a foot above the permanent shell (already in the ground). As a single rod was used for the reinforcement of each pile, it was necessary also to hold the rod in place in the center by means of a rope. This complicated matters to some extent, but the rod was useful in stirring the concrete around so that it flowed freely.

The concrete was poured into the improvised tube, or inner shell, and in flowing to the bottom it forced the water up between the two shells. The hollow tube was raised from time to time and the rod worked around simultaneously. Finally, when the tube was entirely withdrawn, the last of the free water appeared on the surface. Shortly after, the pure concrete showed and was found to be of the best and as originally mixed.

Sag and Slope Diagrams for the Steel Tape

The high degree of precision easily attainable in ordinary surveying and engineering measurements with the steel tape is often not realized, because of insufficient attention to the sag and slope errors. Help in dealing with these errors is furnished by two diagrams prepared by W. H. Rayner, of the University of Illinois, who discussed them recently in a general paper on taping errors, before the Illinois Society of Engineers and Surveyors.

The sag correction is read from the diagram, Fig. 1, which is for a 100-ft. tape. The curves relate to different pulls and give the corrections for any weight of tape.

*3541 Trimble Ave., Cincinnati, Ohio.

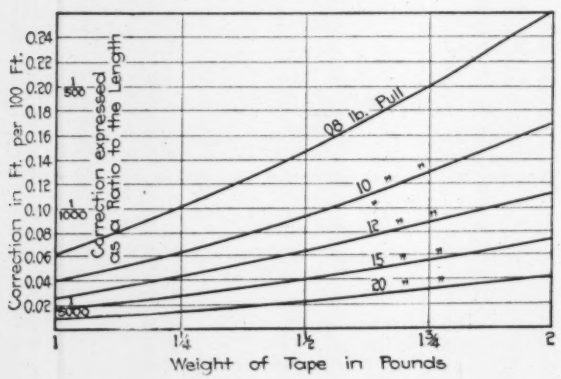


FIG. 1. DIAGRAM OF SAG CORRECTION

Thus, for a tape weighing 1½ lb. the sag correction for 14-lb. pull is 0.04 ft. Ordinary 100-ft. steel tapes weigh from 1¼ to 2 lb. Mr. Rayner believes that the average pull is lower than commonly supposed; in standardizing steel tapes 12 lb. is often used.

The slope correction is given by Fig. 2 to the same vertical scale as in Fig. 1. Like the sag correction it is subtractive; that is, the measured distance is greater than the true horizontal distance. Comparing slope and sag corrections, it appears that a 1¾-lb. tape under 12-lb. pull has the same sag correction when held free horizontally as its slope correction when continuously supported on a 4½% slope. This means that (when no corrections are applied in taping) it is probably better on slopes less than 5% to make measurements with the tape lying along the slope (continuously supported), since the error thus introduced is no larger than the sag correction with the tape freely held horizontal. At the same time the precision is improved by eliminating the uncertainties of plumbing down.

Temperature effect was also mentioned by Mr Rayner as important. The difference in tape temperatures between summer and winter measurements may amount to as much as 100° F., sufficient to cause a discrepancy of 3.4 ft. in a mile or, in land measurement, 0.86 acres in a section.

Concrete Water-Meter Boxes

The water-meter boxes formerly used in Dallas, Tex., were made of corrugated iron and cost the city $1.65 each. Recently it was decided to install many new meters, and a cheaper and more durable box was wanted. The cylindrical concrete box shown by the accompanying illustration was designed in the city engineering offices under the supervision of Hal Moseley, city engineer. A contract for 15,000 of these boxes was let to a local contractor for $1.10 per box, complete, including the cast-iron cover.

The box is shaped about like a barrel cut in two. The concrete is mixed 1:2:2½ with ½-in. crusher-run stone. The shell is reinforced with four vertical wires (No. 10 gage), equally spaced about the circumference, and two hoops. The reinforcement is not intended to add materially to the strength of the box; the vertical wires serve chiefly to anchor the iron casting that forms the cover.

The contractor's plant consisted of a tent and a small gasoline-engine driven batch mixer. Steel forms were

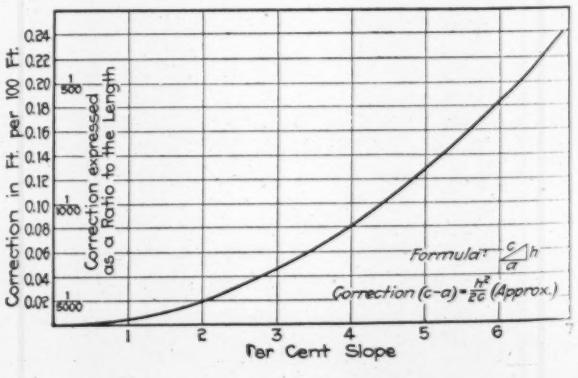
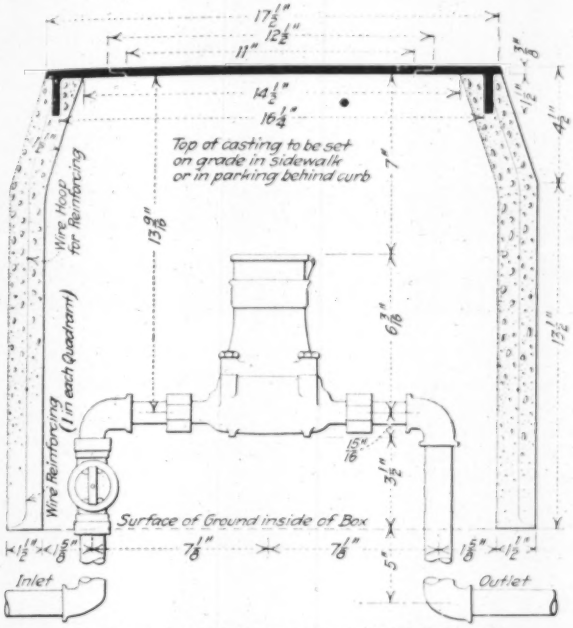

Correction in Ft. per 100 Ft.
Correction expressed as a Ratio to the Length
Formula
Correction (c-a) = h²/2c (Approx.)
Per Cent Slope

FIG. 2. DIAGRAM OF SLOPE CORRECTION

used. At first, corrugated forms were provided, but later the plain forms were substituted. The intention in adding the corrugations was to lessen the tendency of the box to settle.

With five men and a foreman 125 boxes can be made in an 8-hr. day. They are costing the contractor in


Top of casting to be set on grade in sidewalk or in parking behind curb
Wire Hoop for Reinforcing
Wire Reinforcing (1 in each Quadrant)
Surface of Ground inside of Box
Inlet
Outlet

DETAIL OF DALLAS CONCRETE METER BOX

labor and materials $1 each. The top is a ⅜-in. iron casting, weighing about 30 lb.

These concrete boxes stand very rough treatment. The breakage in the first 8,000 made was two. Of course, smooth surfaces and perfectly square edges are not insisted upon.

Machine for Laying Drain Tile Without Trenching

A ditching plow for tile drains, with an attachment for laying the tile underground without digging an open trench, is an interesting machine which is being used extensively in Iowa. It is hauled by a cable- and power-operated drum, like the capstan plow for excavating open ditches that was described in *Engineering News*, Feb. 3, 1915.

The hauling rig, or tractor, is shown in Fig. 1. Mounted on the frame is a Continental four-cylinder gasoline engine (cylinders 5x5 in.) with two bevel-gear drives to a shaft having three sprockets with chains to an upper shaft. This construction gives three speeds in either direction, forward and backward movement being provided by a friction expanding clutch that connects to either one of the two bevel-gear sets. From the upper shaft is driven the shaft with differential gear, and from the latter run chains to the driving wheels. The chains are of the Brampton type, running easily on small sprockets.

Between the rear wheels is mounted a 20-in. drum, also driven by chains. When driving from the slow gear to the drum, the ratio is 1 : 333. The drum carries 300 ft. of 1-in. cable, extra lengths being attached when laying tile across swamps too soft to carry the tractor hoist. For hauling the cable the tractor is held by 6-ft. anchors of steel channels, which are handled by a block and tackle, the cable leading back to a small drum on one of the shafts. In Fig. 1 the anchors are shown raised, and the tractor is ready to move ahead, paying out its cable.

Plow and Pipe Layer

The plow has a vertical colter 8 ft. long, connected by a beam to an axle (with pair of wheels) to which the hauling cable is attached. The colter is a flat bar, which simply shears through the ground and does not cut a trench. At its lower end is a "mole," or horizontal boring head, 2½ ft. long, with a flat top. The rear end of this is circular and large enough to receive the end of the pipe to be laid. The depth of cut is regulated by means of a jack on the axle, which raises or lowers the front end of the plow beam.

At the rear end of the mole is attached a steel carrier, 210 ft. long and of semicircular section, to receive the tile. When the colter is at its proper depth, a feed hole is excavated behind it to the full depth. A man stands in this hole and places tile on the carrier as it passes beneath him. When the plow has traveled 210 ft., it is stopped, and another feed hole is dug.

Fig. 2 shows the complete outfit. At the left is the tractor, ready to move ahead 210 ft. and pay out the cable. In the middle is the plow, with men sitting on the beam. The handle shown over the wheel is that of the jack previously mentioned. At the right (and just to the right of the tile lying on the ground) is the feed hole ready for the tile layer, with a load of tile at hand

FIG. 1. TRACTOR WITH POWER-OPERATED DRUM FOR HAULING DRAINAGE PLOW

FIG. 2. OUTFIT FOR LAYING DRAIN TILE UNDERGROUND

for him to place in the carrier as it passes along at the bottom of the hole.

The grade is kept by means of a level set to the desired grade and sighted upon a target on the colter. This is under constant observation. Tile 3 to 10 in. in

diameter can be laid in this way at depths as great as 5½ ft. and at an average rate of 100 rods per day at a depth of 4 ft.

The machine was designed and patented by H. M. Fisk, Pella, Iowa, and the first one was built at his shop in 1908. It has been used extensively by C. W. Schwidde, Shenandoah, Iowa, who is a contractor for farm tile drainage and who has furnished information about the machine and its work.

NOTES

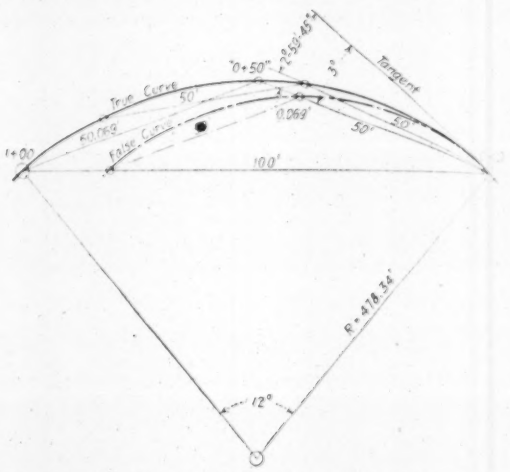
Checking Forest Fires With Dynamite—Everyone knows it is a very difficult matter to stop a forest fire after it has gotten a good start. It is also a well-known fact that the trunks and foliage of the trees do not burn readily, because they are green. The fire usually spreads and feeds upon the dry material upon the ground under the trees. Therefore, any method that will prevent the fire from spreading along the ground will generally effectively check it. W. H. Vanderbilt was recently intrusted with the task of stopping a

PART OF THE DYNAMITED FIRE LINE
Two rows of holes 36 in. apart in both directions; two sticks of "Gelatin" per hole

forest fire near Lynnfield, Mass. His method was to put down two parallel rows of bore holes 36 in. apart, spaced 36 in. apart in the rows. Each hole was loaded with a charge of one pound of low-freezing "Gelatin" dynamite. The charges were primed with electric blasting caps and fired electrically. The result was a broad shallow ditch, shown in the photograph. This ditch prevented spread of the fire. This work was done successfully in spite of the fact that the thermometer ranged from 24 to 32 deg. F.—George F. Lord.

Repaving Over Public-Utility Excavations in the streets of Los Angeles, Calif., has been done by the street department since July, 1914, at the following rate per square foot: Brick, 35c.; asphalt, 25c.; macadam, 17c.; oil and gravel (also for ungraded-street surfaces), 1c. "These rates," says Thomas Brooks, assistant superintendent of the Los Angeles water department, in his latest annual report, "are slightly in excess of the cost when the water department did its own repaving, but the results are more satisfactory, inasmuch as the City Engineer's office bears the responsibility and expense of any imperfect or faulty work."

Short-Chord Calculation in Curved-Bridge Layout—In ordinary railway work short chords are often put in with deflection angles in the same ratio to the deflection of the main chord that the length of the short chord bears to the length of the main chord. For the layout of bridges on curves the error of this method is usually serious, especially because in a long bridge it is cumulative. The diagram herewith, by



Lindsay Swan, Kettle River Ry., Penticton, B. C., illustrates the nature of the resulting error. The correct procedure when, say, a 12° curve is to be laid out in true 50-ft. chords is to compute the deflection angle (a) for this short chord (c) by the formula derived directly from the semicircle triangle: $\sin a = c \div 2R$, where R is the radius of the curve. The radius of a 12° curve being 478.34 ft., the formula gives $50 \div (2 \times 478.34) = \sin 2° 59' 45''$, or 15" less than the deflection angle of 3°, which might be taken in ordinary curve work. For curves of 5° or less the correction becomes negligible.

Three Water-Meter Testing Tanks in One—The water department of Los Angeles, Calif., uses a reinforced-concrete water-meter testing tank 12x12 ft. square on the inside. One corner of the tank is walled off, and in that corner a 22-in. sheet-iron pipe is concreted in. This arrangement gives three tanks with capacities 1,000, 100 and 10 cu.ft. respectively. The three tanks or compartments are connected with a glass tube placed on the outside. This tube is graduated and equipped with a burette float. According to the latest annual report of George Read, meter and service superintendent, this three-in-one testing tank "was not alone necessary for the testing of large meters in regard to accuracy on heavy flows, but it was also necessary in order that the department should know the loss of flow on 3-, 4- and 6-in. services due to the installation of meters, especially when a meter is installed on a service covering both fire and domestic use." Mr. Read continues as follows: "In testing we found a retarding of flow from 2% to 55% through different kinds of meters. The tank also enables the department to purchase a meter more intelligently according to the use and conditions under which the meter is to be used."

Paving by Day Labor at St. Paul, Minn., on 20 jobs cost a total of $334,130 in 1915, compared with contract bids totaling $374,370 and the engineer's estimate of $366,960. The total saving was $40,240, or 12%, as compared with the contract prices, and $32,830, or 9.83%, when compared with the engineer's estimate. On the separate jobs the excess of contractor' bids over actual cost ranged from 2 to 25.3%. In only one case was the engineer's estimate lower than the actual cost, and that was by only 3%. Besides the 20 day-labor jobs there were three jobs done by contract, the prices bid in these cases being below the engineer's estimates and totaling $197,100 against $213,424, or 8.1% in favor of contract work. The city charter provides that the city must advertise for bids on all construction work. The practice with paving is for the city to do the work by force account when the bids are higher than the engineer's estimates, taking into account inspection costs on contract work.

Water-Meter Removals for Failure To Operate, at Los Angeles, Calif., have averaged about one meter removed to each 200 meters in service for the period from 1908 to 1915. On June 30, 1915, the city had 69,628 meters in service. The shop force for keeping these meters in order consisted of a foreman, four repairmen, one man for testing, a store clerk and a janitor. Practically all of the repairing is done with three men.

Editorials

Increasing Loads and Stresses on Highway Bridges

Brief reference was made in the issue of Mar. 16, page 533, to an investigation of the strength of highway bridges in New York State now being made by a legislative committee. Some paragraphs from the preliminary report of this committee present the highway-bridge situation in such a striking fashion that they are worth quoting:

> The general character of the traffic over highway bridges in the State of New York has changed more since the year 1900 than it changed during the whole nineteenth century.
>
> Vehicles propelled by mechanical power are increasing in their size and weight and their consequent stresses upon bridges nearly as fast as they are being increased in number.
>
> The usual requirement of strength for highway bridges in New York State in the year 1900 was approximately the same as the requirement of strength for such bridges in the year 1800. The requirements of strength for highway bridges in the year 1916 are approximately four times as great as in the year 1900.

A vast amount has been published concerning the necessity of improving road surfaces to carry automobile traffic, but very little concerning the necessity of rebuilding highway bridges to make them safe for heavy high-speed machines. There is little doubt that the State of New York, with its dense population and wealth, has bridges on its main highways which are at least as safe and strong as the highway bridges in any state of the Union. It is estimated, however, that to bring the bridges of New York State up to a safe strength to carry present-day motor vehicles would cost at least $30,000,000. If this is the estimate for a single state, one can form some idea of the enormous outlay that will be required to build safe highway bridges throughout the United States or even throughout the limited sections where the use of heavy motor vehicles may be expected in the near future.

In this connection it is well to place emphasis on an important resolution adopted at the recent Pittsburgh meeting of the American Road Builders Association:

> Resolved, That this association urges that laws be passed and enforced in each state establishing reasonable limits for the weight, dimensions and speed of heavy motor vehicles.

At the present time engineers responsible for highway-bridge design are literally at sea in determining what maximum loads should be specified for safe construction. The automobile-truck manufacturers unfortunately have taken the very narrow view that legislation fixing maximum weights for motor vehicles should be opposed and have made the absurd demand that bridges should be built strong enough to carry any load that may come up them.

The predicament of the highway-bridge designers faced with this demand may well be compared to the situation of a railway chief engineer who should be instructed by his superior officer that all limitations as to locomotive weights and wheel loads in the rolling stock used on the road had been abolished and he was henceforth to design his bridges for any load that could come upon them.

As has been frequently pointed out in these columns, more damage may be done to a road surface by a few exceptionally heavy vehicles passing over it than by all the rest of the traffic. Similarly, it is the few exceptionally heavy vehicles that stress bridges beyond their safe strength and which are responsible for many of the too common highway-bridge accidents. Enough experience has now accumulated in the operation of motor trucks to indicate that, except where a truck is to be used entirely on paved city streets, a vehicle of moderate load capacity will render more economical service year in and year out than an abnormally heavy vehicle. Builders of motor trucks will in the long run advance the interests of their industry as well as the interest of the public if they will join with highway engineers in the framing of reasonable restrictions for the weights of such vehicles.

A Changing Labor Market

Less than a year ago, cities all over the country were wrestling with the difficult problem of unemployment. The number of men and women destitute through lack of work overtaxed the capacity of all the organized charities and formed a social and economic problem of the first magnitude.

In less than 12 months the country has passed from one extreme to the other, and at the present time there is a scarcity of labor in comparison with the demand such as has not been witnessed for a generation. This condition is only in small part due to the demand for workmen by factories making goods for export to the warring nations of Europe. That demand has had a large influence indeed in raising the market prices for labor, but other causes have operated to reduce the supply of labor hitherto available.

For the past 20 years some hundreds of thousands of immigrants from Europe have annually been poured into the American labor market. In the summer of 1914, however, with the outbreak of the war, the inflow of immigration was stopped as if a gate had been shut. In its place there has been a considerable flow of foreigners back to Europe. The effect of this on the labor market in America was masked for a time by the general paralysis of business, but with the revival of business in the latter half of 1915 the diminished supply of labor became evident.

During the construction season of 1916 efficient labor is going to be difficult to obtain and to hold, and increases in wage scales are reported on every hand. The prompt adjustment of the wage scale by the conference committee of the bituminous coal-mine operators and representatives of the miners' union appears to have been due, in part at least, to realization by the operators that the law of supply and demand would make necessary an increase in the scale of wages anyway, in order to hold their employees. Necessity is thus made a virtue.

A good illustration of the changed conditions in the labor market is reported from Chicago. The Civil Service Commission of Chicago holds examinations of applicants for employment at stated intervals. Last August examinations were held in 25 wards of the city of applicants for employment as laborers, and 1,668 men took the examinations. In February similar examinations in the same wards were taken by only 501 candidates.

There has been much speculation as to what will take place when the war comes to an end, and it has been freely predicted that a flood of immigration from Europe such as has never before been seen will flow toward America. It is surprising to learn that some careful expert investigations and inquiries which have recently been undertaken by large employers of labor indicate that instead of immigrants coming here when the war ends, there will probably be a large emigration from America to Europe as soon as the war is over. The governments of the warring nations, which have suffered such heavy losses from their working force, are likely to place every obstacle in the way of the diminution of their remaining labor supply by emigration to foreign lands. This will hinder the renewal of the great tide of immigration that formerly flowed to the United States. In addition, there are a vast number of foreigners in the United States who are held by ties of home and relationship to their native land and who will be drawn back there as soon as normal conditions are reëstablished in Europe.

Of course, other conditions not now foreseen may come in to modify this result, but it is of interest to know the results of this expert investigation with respect to the future labor supply.

Preventing Corrosion in Piping Systems for Hot Water

Three years ago, in *Engineering News*, of Feb. 13, 1913, there was published a valuable paper by F. N. Speller, of Pittsburgh, Penn., describing investigations to determine the cause of the rapid corrosion that frequently takes place in the piping used for hot-water supply systems, especially in hotels and apartment houses where the quantity of water heated is very large. As many readers will doubtless recall, Mr. Speller's investigations, carried on in connection with the research laboratory of the National Tube Co., showed that the corrosion of water pipes in hot-water supply systems is due chiefly, if not wholly, to the dissolved oxygen in the water, which is released when the temperature of the water is raised. Corrosion from this cause has in some notable cases ruined the hot-water piping systems of large hotels within two or three years after their installation. A method that has been found successful in preventing this corrosion is heating the water in open tanks prior to its circulation through the system, whereby the dissolved oxygen is driven off.

Additional information on the same subject was given by Mr. Speller in a paper at the annual meeting of the American Society of Heating and Ventilating Engineers. After reciting further investigations in connection with bad corrosion of piping systems Mr. Speller refers to some new methods that are being developed for the protection of piping from corrosion. It has been found that, while the piping in certain exhaust-steam heating systems was corroded very rapidly, other piping was almost entirely free from corrosion; and the cause in the latter instance has been traced to a small quantity of oil carried forward with the exhaust steam. Mr. Speller suggests that in certain cases where the presence of oil in the pipe would be unobjectionable a small quantity of oil could be systematically fed into the current of steam to protect the pipe interior.

Another plan that has been tried on a small scale is the removal of dissolved oxygen from the water prior to its circulation through the system by passing the water through a chamber filled with finely divided iron. Experiments were first made using clean iron turnings in the chamber. Later, there was substituted in place of these a mass of sheet iron so formed as to provide a large number of channels through which the water would flow. Experiments with this apparatus showed a reduction of oxygen content in the water circulated from an original content of 8 or 9 c.c. per liter to 0.1 to 1 c.c. per liter. Other experiments have shown that, with an oxygen content of 1 c.c. per liter or less, corrosion is reduced to a negligible amount.

It will be understood that these methods of de-oxygenation of water are suggested as alternatives when for some reason or other the open feed-water heater method of de-oxygenation is objectionable. Mr. Speller estimates that with proper attention to de-oxygenation of water before entering a hot-water piping system it will be possible to make the life of the piping four or five times as long as it would be otherwise.

It will be readily appreciated that in most cases where piping systems suffer from corrosion the loss is not merely the value of the piping destroyed. Oftentimes the injury to decorations, wall finish, flooring, etc., and the interference with the use of the building during the necessary repair work may together make the damage due to the corrosion of the piping a dozen or twenty times the value of the piping injured. Mr. Speller's investigations of methods for protecting such piping, therefore, are of great value.

Value of Expert Advice

Sound and illuminating ideas on expert advice are expressed in a few brief and forcible sentences in the latest annual report of A. H. Dimock, city engineer of Seattle, Wash. After urging the importance of planning city improvements to meet the needs of the future, Mr. Dimock says:

> In this connection I would urge the value of expert advice. No one man—no matter how expert he may be in any particular line—is capable at all times and under all circumstances of exercising a calm and unbiased judgment. The value of expert advice lies largely in the thorough discussion of any given problem from several points of view by men properly qualified to weigh and evaluate the conditions underlying such problems. The tendency of such discussion must necessarily be to even up the idiosyncrasies of the individual engineer and to secure a better-rounded and more harmonious plan.
>
> There is, however, some tendency in this city to accept the advice of any experts who may be called in as binding. This tendency should be discouraged for the reason that the judgment of the expert is only one factor entering into the solution of the problem. His opinion will naturally have greater or less weight depending upon his eminence in his profession and his experience in dealing with familiar problems.
>
> The judgment of these men who have given years to the study of any particular local problem is, however, an element

which must also be considered. These men would be the first to appreciate at its true value the testimony of outside experts. The value, however, of reports and opinions of those who have given their lives to the study of certain specialties is nevertheless very great indeed, and such advice should always be secured before the settlement of any important problem. The City of Seattle can make no investment which will return a larger percentage of profit than to secure the best brains of the country.

An interesting subject for consideration is the extent to which Mr. Dimock's warning as to the danger of regarding expert advise as absolutely binding deserves attention in other places than Seattle. To outsiders who have followed happenings in Seattle for a dozen years past, it does not seem that the governing body of that city has ever given overmuch heed to well-selected expert advice, but doubtless Mr. Dimock knows whereof he speaks.

Army-Engineer Examinations

Announcement has been made by the Chief of Engineers of the United States Army that the next examination for appointment as second lieutenant in the Engineer Corps will be held about August 21 next. It will be remembered, however, that a prerequisite for taking this examination is qualification for appointment as junior engineer in the Engineer Department at large. The examinations for this latter position will be held by the United States Civil Service Commission, Apr. 12 and 13, 1916.

Those young engineers, therefore, whom the recent commissioning of six civilians in the Engineer Corps has encouraged to aspire to similar appointments must be prepared to take these April examinations, if they are not already qualified either by previous examination or by their positions in the Government service. While there has been no official intimation of the fact, it is more than probable that, in view of the current military agitation, the civilian appointments this year will be greater than ever before.

Movies Keep Workmen on Job

It is a very common complaint of contractors, particularly those doing work in remote sections of the West and those who are employing chiefly unskilled labor, that it is exceedingly difficult to hold the men on the work. After every payday a large proportion of the men make for the nearest town to spend their money, and it is a common saying that three gangs are required to keep the work going—one on the job, one going away and one coming back after sobering up.

A lumber company in northern Wisconsin has introduced motion pictures this year as a means of keeping its workmen in the logging camps contented, with, it is stated, remarkable results. In former years the crews in the camps of the Guerney Lumber Co. were almost entirely changed every 30 days. After a man had gone to the city to spend his wages, he was quite as likely to go to some other camp for a job as to come back to his old place.

As an experiment the company this year secured a motion-picture machine and an operator, and a motion-picture show is given every night. The old difficulty with constantly changing crews has disappeared. The men are charged a small admission fee, which they willingly pay, and the little building where the pictures are shown is crowded every night. The men stay contentedly on the job and are in much better physical shape than under the former conditions.

Vacancy for County Engineer; Salary, $300 per Year

Engineers in the public service and those ambitious to enter it will no doubt be interested, though not necessarily pleasurably so, in the value placed upon such engineering ability by the Nodaway County Court of Missouri. The following comment is from the Maryville *Tribune* of Feb. 11, and its facetious vein awakens hope that even the layman regards $6 per week as an insufficient "honorarium" for faithfully discharging the duties of county engineer:

> Wanted—One first-class county highway engineer, of assured ability; salary, $300 a year.
>
> Anybody who wants the job, can prove that he is capable of doing the work necessary and is willing to accept the position of county highway engineer at a compensation of $300 a year may get the appointment upon application to the County Court. Not so fast, gentlemen; give the head of the line a little room.
>
> For that's the salary the County Court has offered the man who wants to accept the job. The court received two applications—one from the former engineer, John H. Clary, at $1,500 a year with expenses; the other from the present engineer, J. E. Reese, who offered to fill the office another year at a salary of $720, paying his own expenses. Both were rejected.

Engineering News is unacquainted with conditions in the county in question and, therefore, leniently concludes to suspend sentence on the seemingly penurious Nodaway County Court.

The bill making it possible for the local health boards in New Jersey to transfer the inspection and testing of new plumbing to the building department, whenever any such board decides that plumbing control is not its proper function, is a move in the right direction. The bill was proposed by the New Jersey Health Officers' Association and has been indorsed by the State Department of Health. The latter rightly urges that plumbing has comparatively little relation to public health; that building operations are hindered and unnecessary annoyance and expense caused by the duplicate filing of plans and duplicate inspections; and that "it is imperative that the energies and resources of local boards of health should be concentrated on those lines of work which have the most direct effect on the saving of lives and prevention of sickness." It might be added that some of the less progressive boards of health think their duties begin and end with plumbing and nuisance inspection and expend their meager appropriations for such work, to the neglect of vital health issues.

A new and telling good-roads slogan, "365-Day Roads," was used in working up attendance and interest at the highway-engineering conference held early this month at the Kansas State Agricultural College, Manhattan, Kan. The pertinence and efficiency of such a motto are further shown by the existence of a "365-Day Road Club," which has been organized in Kansas. These facts need no comment for those who know what country roads are for many days of the year in the sticky-soil portions of the Middle West, as well as the South.

Letters to the Editor

Rating the Qualifications for Success in Engineering

Sir—I read with much interest the editorial in *Engineering News* of Mar. 2, 1916, on the qualifications for success in engineering and I am very glad you expressed yourself in the way you did. It is safe to say that few men can judge accurately the causes of their own success or failure, much less that of their neighbors. As an engineer rises in the world, his technical knowledge becomes so much a matter of instinct that he almost forgets that he has it. His knowledge becomes broader and less detailed. He forgets all, or nearly all, the formulas for integration, but he understands the broad principles of integral calculus better than the young graduate.

I am sorry for the apparent tendency to underrate the value of technical training. The vast majority of engineers are engaged on work that is principally technical. The personal qualities mentioned, and rightly, as of paramount importance to the highest success of an engineer—or almost any other kind of man, for that matter—are pretty fully developed at least five years before the young man ever enters a technical college and are due more to his family and neighbors than to anybody else.

If one reads history carefully, he will see that a long and bloody war is a prelude to a more or less complete stagnation in the intellectual progress of the people involved. They are at present engaged in a wholesale slaughter of the flower of European manhood, and the end is not yet. The old men are left—but not for long—and there are few young men coming up to take their places. It will be largely the duty of Uncle Sam and his nephews and nieces to carry the torch of progress and learning for many years to come. It therefore behooves us to play our part with the highest skill and train ourselves assiduously to take and hold the place that will be waiting for us. WILLIS WHITED.

Harrisburg, Penn., Mar. 8, 1916.

Sir—Your editorial on "Rating the Qualifications for Success in Engineering," in the issue of Mar. 2, was interesting and to the point. I received one of Professor Mann's cards and in answering I rated "character" first and "knowledge of the fundamentals of engineering science" second, adding that if a man did not have this knowledge he would not be an engineer, although he might be a successful business man. A man cannot be a "successful engineer" unless he has character; but a knowledge of his profession is certainly a prime requisite for success for any man, no matter what that profession may be.

The conclusions drawn from answers to such inquiries are not likely to be of much value in helping determine the best methods of instruction for students of engineering; but Professor Mann's work has been of great value, inasmuch as it forcibly calls the attention of the young men in the profession to the fact that so many of the older members place integrity above every other element requisite for success, not even excepting professional knowledge. PALMER C. RICKETTS.

Troy, N. Y., Mar. 4, 1916.

Sir—The result of the Carnegie Foundation classification and weighting of the desirable qualifications of young engineers based on a canvass of several thousand practitioners does not constitute a very tangible or adequate guide to those directing our great technical schools.

Out of the six counts on which judgment is rendered, five—character, judgment, efficiency, understanding of men and technique of practice and of business—are the qualifications desirable in all young professional men—surgeons, lawyers, engineers and divines—who are to serve well and reach the high places in life. If the words "technique of practice" be not construed too narrowly, these qualifications apply equally well for young business men—bankers, manufacturers and merchants. In short, they mark an all-round promising young man and are almost as obvious as good health and cleanliness.

Perhaps the conclusion that, after all, an engineer is just a man and primarily must have the qualities that win in all vocations and professions is the important vital truth in the verdict rendered. If these qualities exist, add a knowledge of the fundamentals of engineering science and something of its technique, and we may expect a successful engineer.

Those of us who are directing young men through a five-year collegiate course in engineering—in which more than 85% of the work pertains to the science and technique of engineering—must be keenly cognizant of the fact that character molding, scientific attainment and efficient practice are all going on at the same time in this plastic period of youth.

In the end the product of our technical schools is an apprentice in life and in engineering. In the first ten years of his professional life, qualities of judgment, perspective, responsibility, resourcefulness, accuracy and executive ability will emerge and intensify. These qualities, like winter apples, may not ripen as early as the simpler qualities of integrity and industry, and first employers must expect only reasonable development.

If in our education of engineers we could only reach back and educate their grandfathers and grandmothers, their fathers and mothers and guide our prospective students from kindergarten to college, perhaps our product might be better—but at the present time I believe it is good at Minnesota. FRANCIS C. SHENEHON,

Dean, College of Engineering,

Mar. 13, 1916. University of Minnesota.

Sir—The current inquiry on behalf of the Carnegie Foundation for the Advancement of Teaching, bearing on a proposed standard for engineering graduates, which is also to be used as "a standard in developing staff or-

ganizations and curricula and in selecting efficient methods of instruction" has already received editorial consideration in your issue of Mar. 2. For the sake of brevity I shall venture to state my views categorically and seemingly, at least, somewhat dogmatically, as follows:

1. It may be doubted that any artificial standard can be devised for gaging the merits of men of widely varying characteristics in relation to unknown duties of equally diversified kinds. It would be sufficiently difficult to establish a fixed standard for a given position, much less for a profession such as engineering, of the broadest range.

2. The six factors and their relative weights in the standard reported by Dr. Mann are suggestive of criteria for ultimate rather than initial professional fitness. Different standards, to say the least, should be applied in testing the qualifications of young graduates for service as professional privates and those of more seasoned men for positions of leadership, although both, especially the latter, are so varied in their requirements that no single standard may be expected to serve for either.

3. The specifications for young graduates may be limited essentially to character and a knowledge of engineering fundamentals as to theory and practice, with incidental regard to personality, according to the requirements of the position and in particular as to the absence of pronounced personal crotchets, without any attempt at an exact quantitative evaluation of the several elements. With such "initial qualifications" assured, the graduate and his prospective employer may well rest content, leaving the question of professional growth to the influence of professional soil and environment, by which alone it can eventually be answered.

4. The personal qualities for ultimate success in engineering and, indeed, in every other field of human endeavor are in the main inherent—that is, capable of development, but not of creation. Moreover, the extent to which such qualities may be capable of development can be determined only through the actual seasoning process in practice and cannot safely be predicted even from an intimate acquaintance with the young aspirant at graduation.

5. Standards determined after full discussion by a group of men, carefully selected for their fitness, individually and compositely, may fairly be expected to command greater confidence than averages struck from over a thousand miscellaneous replies to a circular inquiry. In support of this view the present rating of only 13% for a knowledge of engineering fundamentals on the part of young graduates may be cited without comment, from which it is rather difficult to refrain.

6. The six factors in the present tentative standard fail to take account, or adequate account, of the vital element of personality, with such important attributes as presence, temperament, forcefulness, self-reliance, tact and affability; and that of general culture, in the sense of intellectual development along nontechnical lines, breadth of interests, and accuracy and readiness of expression in speech and writing. And yet it can hardly be doubted that these two elements—personality and culture—are of very great importance, and not infrequently of governing importance, in influencing elevation to the highest professional levels. It is of course conceded that the acquirement of an effective personality depends essentially on traits inherent in the individual, but is that not true also of executive ability? Why then discriminate?

7. In determining the relative merits of individuals it may be doubted that any artificial scheme by which the value of a man is estimated, as the sum of the products found by multiplying assumed grades for various characteristics by factors representing their assumed relative weights, can reasonably be expected to supersede the usual practice by which men are "sized up" and appointed or promoted on their known personal and professional records. If in the case of young men the latter is not adequate, an examination test may be readily applied.

8. Finally, as to the practical possibility of applying any fixed standard or set of standards to engineering curricula and methods of teaching, which must necessarily also include teachers, equipment, administrative methods, entrance requirements and the degree of their enforcement, I confess that I should prefer to refrain from comment until the proposed methods of attacking a problem of such bewildering complexity shall have been more definitely enunciated.

That much good will flow from the current investigation of the present status of American engineering education and the possibilities of improvement is to be confidently anticipated, even though the prospects of practical results from the particular phases of this investigation here discussed may not seem very hopeful. Though recognizing that there is always room for improvement, the need or possibility of sudden revolutionary changes in American engineering education is not apparent to the writer.

EDGAR MARBURG.

University of Pennsylvania, Philadelphia, Mar. 16, 1916.

Engineer's Cost Estimate

Sir—While I do not believe that any bidder has a right to base his cost estimates on the estimate made by the engineer who designed the work and while I believe it is the duty of every contractor to know enough about costs to make up his own estimates, I must take exception to the manner in which "An Engineer" arrives at the cost of a cubic yard of concrete, on page 477 of *Engineering News* of Mar. 9.

To begin with, estimating reinforcing steel and forms by the cubic yard instead of by the pound and square foot is not a scientific method. However, "An Engineer" states that "mixing and placing and water and waterproofing could cost $1 per yd. under difficult conditions." I believe that $1 per yd. for mixing concrete and placing it in a wall 33 ft. high is not enough; and that to it must be added the cost of 13½ sq.ft. of waterproofing (one side) at 1½c., which equals 20c., and the cost of 27 sq.ft. of surfacing (two sides) at 1c., which is 27c., making a total of 47c.

I have allowed only 1c. per sq.ft. for surfacing, on the assumption that the job did not require more than the most perfunctory finishing, but even the figures I have given show an increase of 4% in the cost of the concrete.

In these days of sharp competition a 4% increase in cost would have a very serious effect upon a contractor's profits.

CHARLES F. DINGMAN,
Flynt Building and Construction Co.

Palmer, Mass., Mar. 10, 1916.

Rusted Pony Truss Collapses at Johnstown, Penn.

SYNOPSIS—Pony-truss highway bridge with some members in advanced stage of corrosion. Heavy overload, considering reduced sections. Failed slowly and settled uniformly, owing to rigidity of crossframing. City engineer had recommended repair or replacement.

On Mar. 21 a single-span pony-truss highway bridge across the Conemaugh River at Johnstown, Penn., collapsed under a heavy load of street cars and foot passengers. While the manner of failure and the low clearance of the structure prevented many casualties, the accident was noteworthy and contains many lessons. At the request of *Engineering News*, C. E. Chase, Inspecting Engineer for Modjeski & Angier, Pittsburgh, went to Johnstown to investigate the failure. There are appended a report by Mr. Chase, illustrated with drawings, and some comment by Edward Godfrey, also of Pittsburgh.

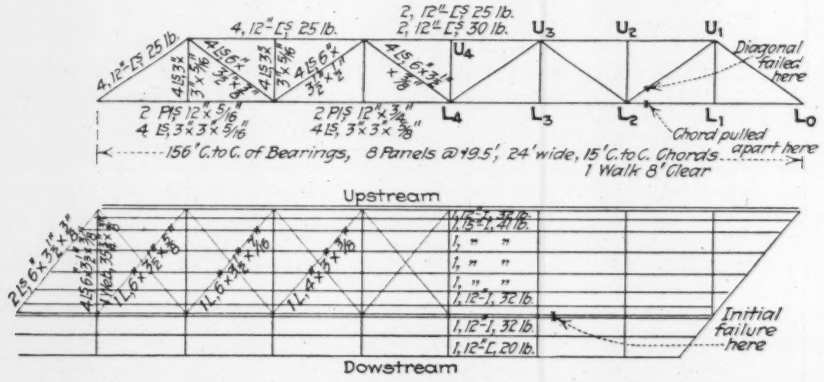

Diagonal failed here
Chord pulled apart here
156' C. to C. of Bearings, 8 Panels @ 19.5', 24' wide, 15' C. to C. Chords
1 Walk 8' Clear
Upstream
Downstream
Initial failure here

FIG. 1. TRUSS DETAILS OF WOODVALE BRIDGE ACROSS CONEMAUGH RIVER

These details were taken from the original drawings of the bridge, but the specifications under which the bridge was designed and the loading details are not available. The bridge has evidently had no maintenance and a high degree of corrosion is apparent in practically all of the members. The section shown in Fig. 2 is typical of most of the members. Corrosion is more advanced at the level of the wooden floor, which fits tightly against the metal parts of the trusses.

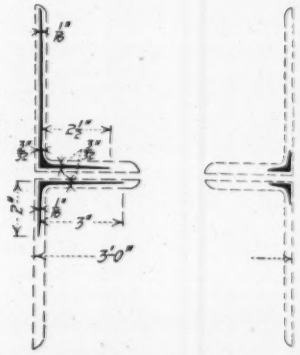


FIG. 2. CORROSION LOSS OF U_1L_2 (DOWNSTREAM)

Original section, shown dotted, four 6x3½x⅜ angles = 13.68 sq.in. Present section, shown in black (estimated) = 2.00 sq.in.

Report on Collapse by Clement E. Chase

Mr. Chase's report is as follows:

That a pony truss has merits of its own—when it comes to failure of the span—is a conclusion that might be drawn from the failure of the Woodvale bridge over the Conemaugh River at Johnstown, on Mar. 21. A large loss of life could hardly have been avoided but for the facts that there was no overhead bracing and that the failure of one truss immediately worked through the rigid floor-beam connections to cause the failure of the other and so allowed the span to settle vertically instead of overturning.

The accident happened just after the day shift had left the Franklin plant of the Cambria Steel Co., when five trolley cars and about 500 men, jammed into the cars and on the footwalk, were waiting on the bridge for the passage of a train on the Pennsylvania R.R. track at the west end of the bridge. The failure was fairly slow and progressive, as an employee of the Cambria Steel Co. in a near-by office overlooking the bridge had time to call police headquarters on the telephone after the first sound of failure and send word that the bridge had started to settle and then that it had failed. The significance of this is in the indication it gives of the sequence of the collapse. As the bridge settled, the trolley cars jammed together in the center, pulling on a sixth car. The men escaped out of the windows, and but seven injuries occurred, only one of which was serious.

The structure was a skew pony-truss span with a 21-ft. roadway and one 8-ft. sidewalk and was 156 ft. long c. to c. of end bearings. It was built in 1895 by the Edge Moor Bridge Works, and apparently was constructed of steel. The dimensions and sections were as shown in Figs. 1 and 3. The bridge originally was designed with both trusses of the same weight, with but one cantilevered sidewalk and no provision for trolley cars. When the single track was laid, it was, with rare judgment, placed nearest to the truss that already carried the sidewalk in addition to its share of the roadway burden, with the result that under the conditions of loading at the time of collapse probably 80% of the load went to that truss.

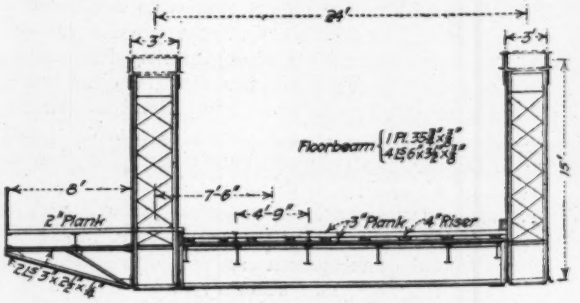
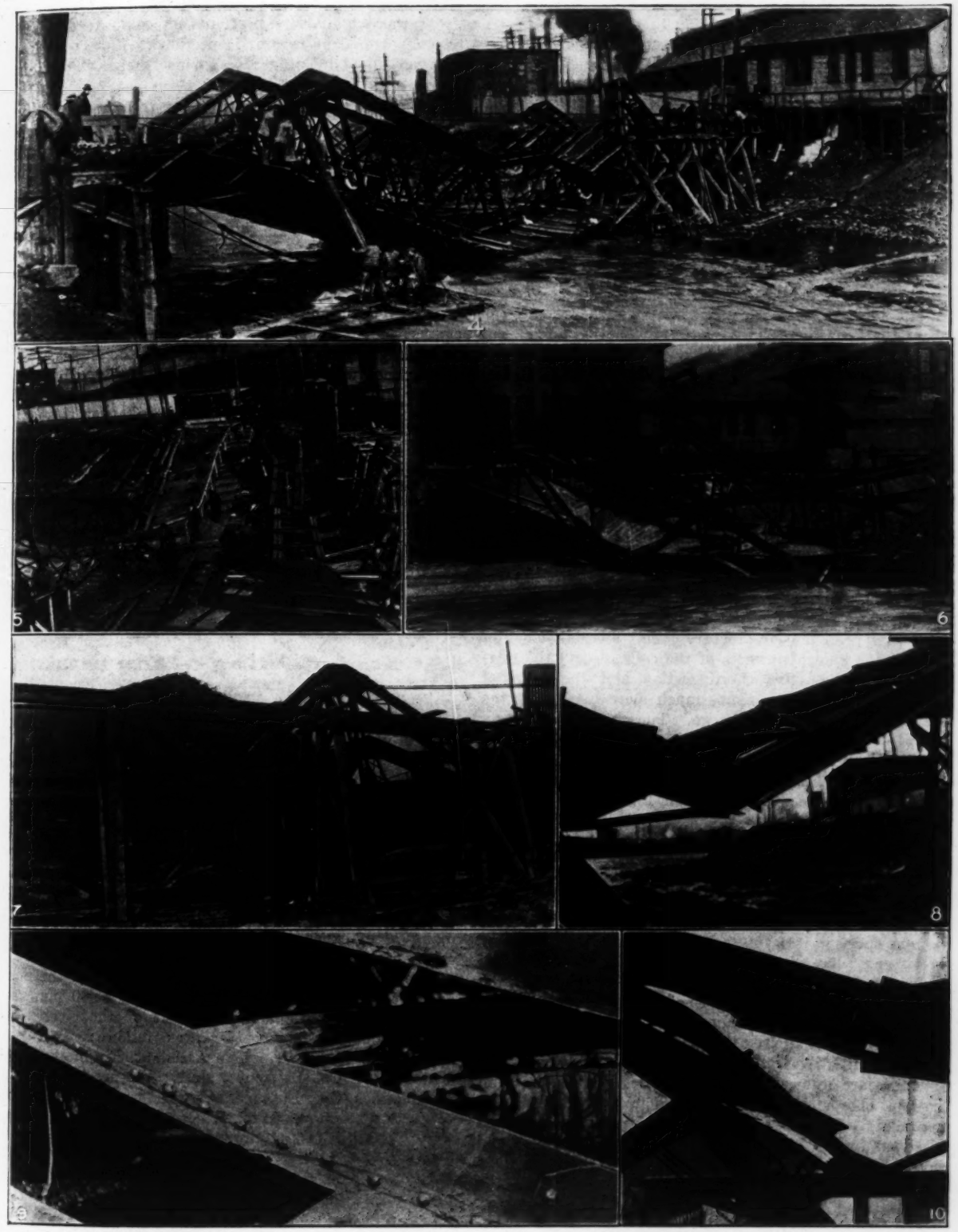


FIG. 3. CROSS-SECTION OF WOODVALE BRIDGE

The design unit stresses seem to have been moderate, probably about 9,250 lb. per sq.in. for live-load stresses in tension, with 18,500 lb. per sq.in. for dead-load stresses.



FIGS. 4 TO 10. VIEWS OF COLLAPSE OF WOODVALE BRIDGE AT JOHNSTOWN, PENN.

Fig. 4—From downstream side, Franklin Works on east bank. Fig. 5—Looking east along top chords. Note that top chord of first truss to fail (on right) did not buckle much laterally, but upstream truss (on left) did buckle opposite broken diagonal. Fig. 6—Eastern end of span from upstream. Fig. 7—East and downstream truss. Note the diagonal U_1L_2 immediately under and parallel to top chord U_1U_2. After failure of the diagonal this panel probably distorted and caused the noticeable settling of the bridge before the bottom chord failed. Fig. 8—Fracture of top chord between U_2 and U_3 of upstream truss. Secondary failure at rivet holes. Fig. 9—Bottom chord L_0L_2 showing corrosion. Outstanding leg of angle entirely eaten through. Fig. 10—Initial break in diagonal U_1U_2.

with unit loadings of about 1,500 to 1,600 lb. per lin.ft. of bridge for live-load and about 2,000 lb. per lin.ft. for dead-load. Although the flooring had been changed from that of the original design, it is not apparent that the dead-load had been greatly increased. The actual dead-load has not been checked, but the two 7-in. girder rails, added floor planking and gas-main pipe possibly amounted to 200 lb. per sq.in. Estimates of the load on the bridge vary from 60 to 85 tons, or a live-load of from 750 to 1,100 lb. per lin.ft. of span at the time of collapse.

Considerations of loading seem rather a waste of time, however, when the condition of the structure is known. Apparently, past Johnstown administrations had expected the bridge to stand up on its record after the steel had rusted away, for the corrosion was most obvious even above the floor line. The space between the legs of the angles composing the diagonals and posts and between the backs of the pairs of channels forming the top chord was entirely filled with heavy scale. The wastage of metal at the level of the timber deck was, as usual, much worse than in the exposed positions. Fig. 9 shows a rather obscure view of one of the inverted T-shaped sections of the bottom chord, with outstanding legs of the angles completely rusted through. The present city engineer, taking office on Jan. 3 of this year, had vigorously condemned the condition of this span, along with others, to the city authorities on Jan. 28 and had asked for an appropriation to make plans for, and execution of, repairs.

Local opinion inclines to the belief that the downstream bottom chord, at about the L_2 point, failed first. This shows a typical tension fracture, "silky angular"; but in view of the known slowness of the collapse and the relative wastages of this chord section and the diagonal U_1-L_2 just above it, it seems much more likely that the diagonal was the first to let go. The chord section may have lost as much as 30% of its original sectional area, but this is quite outdone by the diagonal, which had lost 85%. Two square inches of metal (at a liberal estimate) was left to do the work for which 13.68 sq.in. had been provided (Fig. 2).

Assuming the load on the bridge at 60 tons at the time of failure, the stress in the remaining section of the diagonal would have been 71,000 lb. per sq.in. The failure of this member would cause the settling of the span, which was noticed and would increase the load in the bottom chord nearly 100%. The bottom chord probably broke next; but fortunately at about the same time the dropping of one end of the floor-beam, working through its rigid connection to the post of the other truss, pulled the top chord of the upstream truss out of line and caused its failure. This allowed the span to settle evenly, instead of overturning the trolley cars and men into the river.

There are numerous other fractures of both top and bottom chords in both trusses, but these are clearly secondary. The rivet holes were evidently punched full sized; and when bent by the truss distortion, both top and bottom chords ripped apart, the breaks starting at these rivet holes.

Comments on Failure by Mr. Godfrey

Mr. Godfrey's comments follow:

The writer was in Johnstown on other work, two days after the accident, and he took occasion to give the bridge a casual examination. Enough was seen in the few minutes available to convince the writer that the cause of the wreck was simply deterioration that could readily have been discovered by careful inspection or that could have been prevented by proper design as regards the [illegible] of wood.

The bridge was supported by pony trusses of the Warren type with vertical hangers. The chords were double and well separated so as to give good stability laterally. There was one car track at one side of the bridge. This track was lined with loaded cars when the bridge dropped, and only the short distance that it had to fall prevented an awful disaster. I am told that the local theory of the collapse is that the top chords gave way first. This is totally untenable, for the top chords are not crumpled or buckled, but are torn apart and open at the breaks.

The wooden guard rail of the bridge was close up against the truss members, even being notched out so as to fit snugly against the wide flanges of the angles, which were turned with the backs outward. I observed the hip hanger and the first main diagonal where these had lain against the guard rail. They were broken at this level, and the metal was rusted away so badly that the thickness was $\frac{1}{16}$ in. or less. They looked about as thick as cardboard. The metal had a scale about $\frac{1}{4}$ in. thick.

The writer believes that the first thing that happened was the ripping of these "paper" hip hangers, then the failure of the first main diagonal at the level of the guard rail. This would leave three panels of the bottom chord acting as a beam. This would quickly break and let down the floor. The truss shoes did not leave the abutments.

Annual Meeting of the Boston Civil Engineers

The annual meeting of the Boston Society of Civil Engineers was held on Mar. 15 at the Boston City Club. The business meeting was called to order at noon, and the routine business of hearing the annual reports of the officers was transacted.

It was announced that the society's so-called "Permanent Fund" had reached the amount of $37,475.69 and that in addition to this there had been established the "E. K. Turner Fund" of $1,000, the income of which will be used for library purposes. The total revenues of the society for the year were $9,272, and they were $768 in excess of expenditures, indicating that the society is on a very satisfactory financial basis.

The thirty-fourth annual dinner was held in the main banquet hall of the Boston City Club at 1:30 p.m. and was followed by the announcement of the election of officers for the ensuing year, as follows: President, Richard A. Hale, Principal Assistant Engineer, Essex Water Power Co., Lawrence, Mass.; vice-president, Lewis M. Hastings, City Engineer, Cambridge, Mass.; directors to serve for two years, A. W. Dean, Chief Engineer of the Massachusetts Highway Commission, and S. E. Thompson, consulting engineer, Newton Highlands, Mass. S. E. Tinkham (secretary) and F. A. Whitney (treasurer) were reëlected. In the evening the annual smoker was held at the same place, and a buffet supper was served.

The Desmond Fitz Gerald medal for the paper of greatest merit presented before this society during the year was awarded to William S. Johnson, Boston, for his paper on "Ground-Water Supplies," which was published in the issue of the society's *Journal* for May, 1915.

Railway Engineering Society Has Active Meeting

SYNOPSIS—Report of annual meeting of American Railway Engineering Association at Chicago, Mar. 21-23, 1916.

In a remarkably active meeting the American Railway Engineering Association laid the foundation for much work in the coming year, but added only a few items to its prior standards of track and structures. The three leading subjects of the meeting were clearance, rails and steel bridges. In the first of these a most important standardization was accomplished by the adoption of a new general clearance diagram recommended as a minimum for all future railway construction. The subject of rails produced a remarkably interesting piece of information in a full report on a new acceptance test for steel rails, claimed by its author to be far ahead of the conventional acceptance tests. A new impact formula for steel railway bridges was brought forward as the ultimate product of the association's experimental study of impact stresses, and at the same time an exhaustive review of working stresses was presented by Prof. F. E. Turneaure.

Nick-and-Break Test for Rails

Robert W. Hunt and C. W. Gennet, Jr., gave a full report on the successful application of Mr. Hunt's nick-and-break test for steel rails. United States rolling mills had refused to take orders in which this test governed acceptance, but a Canadian mill that was short of work agreed to use the test for 10,000 tons of rails for the Canadian Pacific Ry., and later for 15,000 tons for the Illinois Central and 3,000 tons for the Rock Island. The results were satisfactory, not only to the railways, but also to the mill. The authors endeavored to prove by figures that the test is a surer detector of bad steel than the drop test now standard or than the drop test supplemented by chemical analysis for segregation, as used last year by the Pennsylvania R.R.

The test requires that the top end of every top rail—that is, a top-of-ingot specimen from every ingot—be nicked and broken and the top rail rejected if interior defects are seen on the fracture. In the latter case the bottom end of the top rail is similarly tested, to govern the acceptance of the next (B) rail; and if this is rejected, its bottom end is used to test for the next (C) rail, etc. Thus, every rail is accepted on the basis of a satisfactory fracture obtained higher up in the ingot; and what is most important, every ingot is tested.

The authors show by figures that the application of this test resulted in saving many rails that would have been rejected under the standard specifications. At the same time the test revealed dangerous defects in many rails that would have been accepted under the standard practice of testing only one ingot out of each heat.

Discussion of the paper brought various expressions of opinion, generally approving, from railway men, but no word from any representative of steel manufacturers. W. C. Cushing made the principal remarks in criticism of the nick-and-break test, which he condemned as not scientific, since it depends not on measurement, but on visual judgment of the inspector. He declared, further, that progressive improvement in rail specifications—which he described as a continuous struggle, a struggle still on—has brought about many improvements in mill and ingot practice and should continue to have this effect, and also that the chief present problem is improvement, not of rail specifications, but of ingot manufacture.

The report of the association's Committee on Rail offered no specific results or conclusions except on transverse fissures. This subject was studied by tabular analysis of very many chemical and other examinations of rails, including over 100 rails containing transverse fissures. The subcommittee concludes that (1) transverse fissures occur indiscriminately over the several rails of the ingot, (2) segregation is not an important factor in causing the fissures, and (3) the present problem is to determine the origin of the nucleus from which such a fissure grows.

A New Clearance Diagram

An intense practical discussion arose over the subject of clearances, and unlike most floor discussions it resulted in the definite acceptance of a new clearance diagram intended for universal application to new railways. That this action was accomplished appeared to be due largely to the firm guidance of the meeting by the president, Robert Trimble.

Recently, there has been much agitation in legislatures and in utility commissions in favor of increasing the clearances of railways, with a view to promoting the safety of railway employees. The American Railway Association called upon the engineering association to recommend a general clearance diagram. The Committee on Rules and Organization studied the question fully and as a result proposed a diagram involving a clearance width of 16 ft. and a height of 22 ft. The meeting considered this proposal, but rejected it. It also rejected a counter-proposal by C. W. Cushing, to fix the width at 14 ft.

For the lower part of the diagram, up to a height of 2 ft. above top of rail, the previously adopted diagram for electrified railways was accepted as a general standard. For the main part of the diagram a clear width of 15 ft. and a clear height of 22 ft. above top of rail, or 22 ft. 6 in. above base of rail, was accepted. The width of full-height clearance was made 8 ft., and the upper limit of full-width clearance was made 16 ft. above top of rail, or 16 ft. 6 in. above base of rail. The lower corner of the diagram was not definitely fixed.

A New Impact Formula for Steel Bridges

A monumental treatise on working stresses for steel bridges was presented by Prof. F. E. Turneaure as part of the report of the Committee on Iron and Steel Structures. He made no specific recommendations, but his presentation of a new impact formula has virtually the effect of a recommendation. The formula is intended to summarize the results of the impact-stress measurements made by the committee and all prior results on